United States
Department of
Agriculture

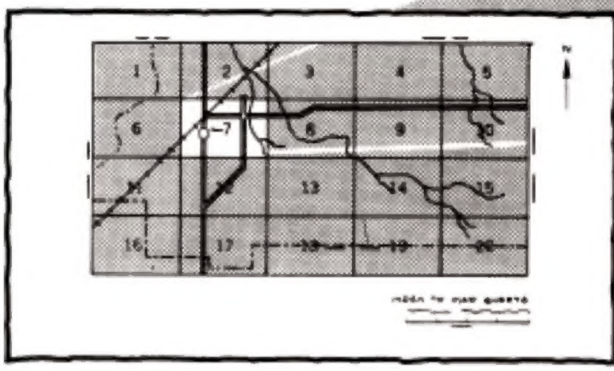
Soil
Conservation
Service

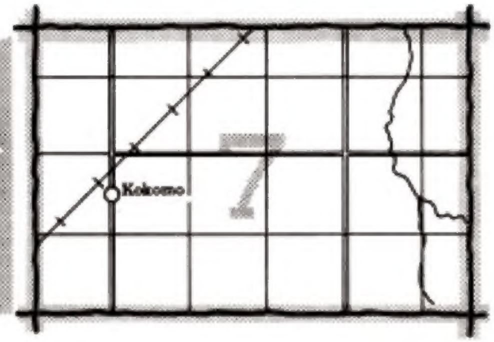
In cooperation with
North Dakota Agricultural
Experiment Station,
North Dakota Cooperative
Extension Service, and
North Dakota State Soil
Conservation Committee

Soil Survey of Kidder County, North Dakota

HOW TO USE

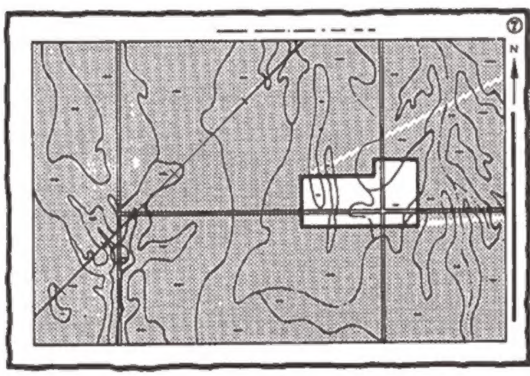
1. Locate your area of interest on the "Index to Map Sheets"

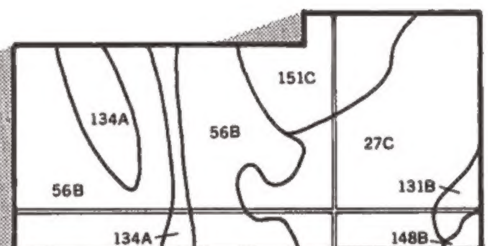




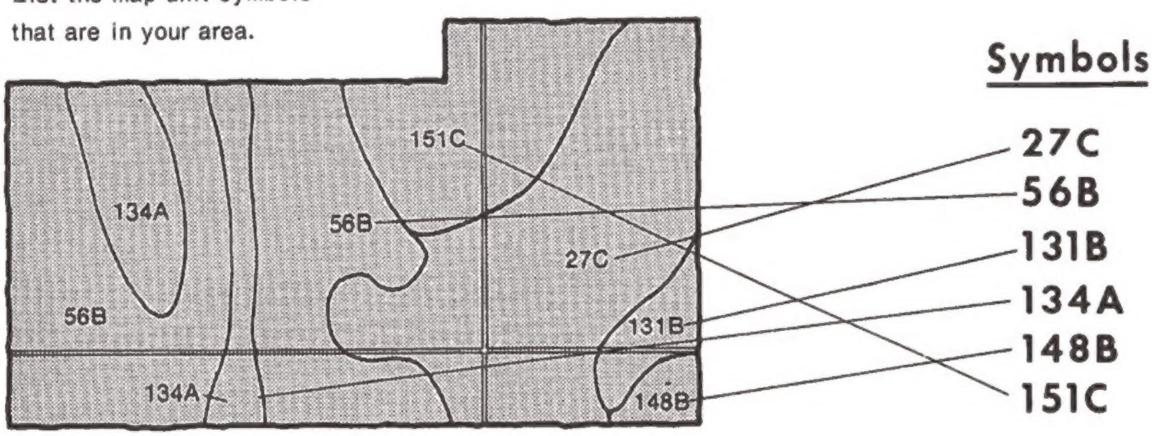
2. Note the number of the map sheet and turn to that sheet.

3. Locate your area of interest on the map sheet.



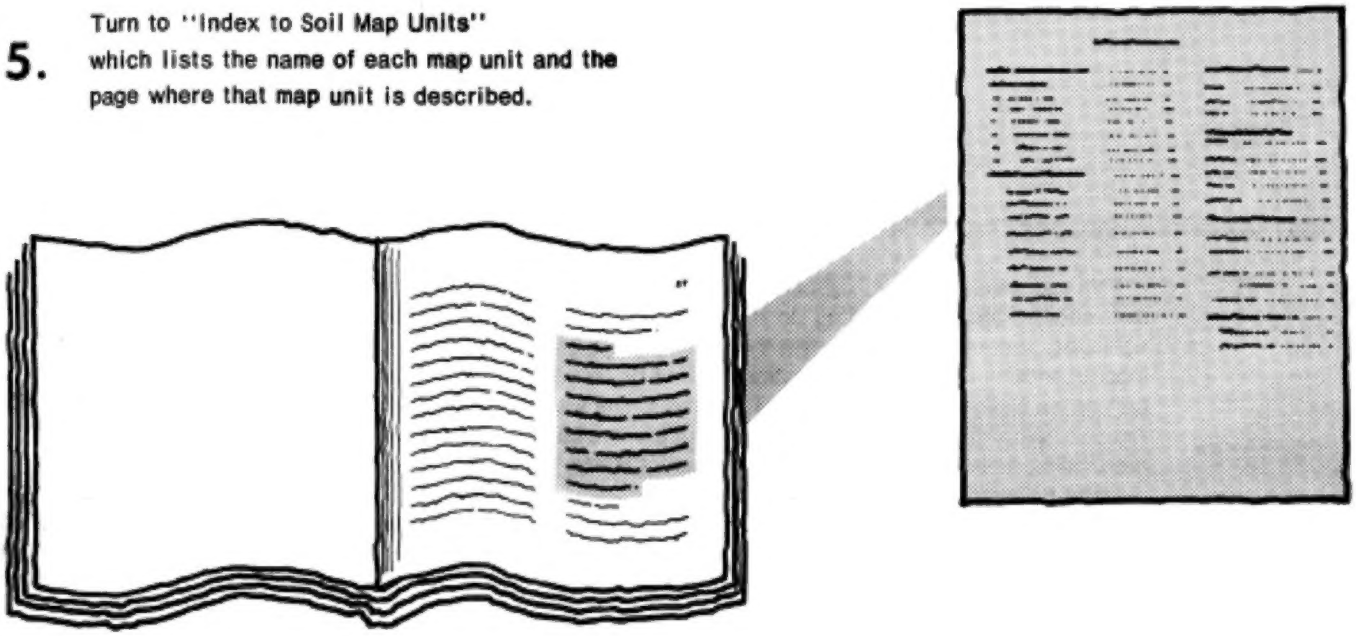


4. List the map unit symbols that are in your area.

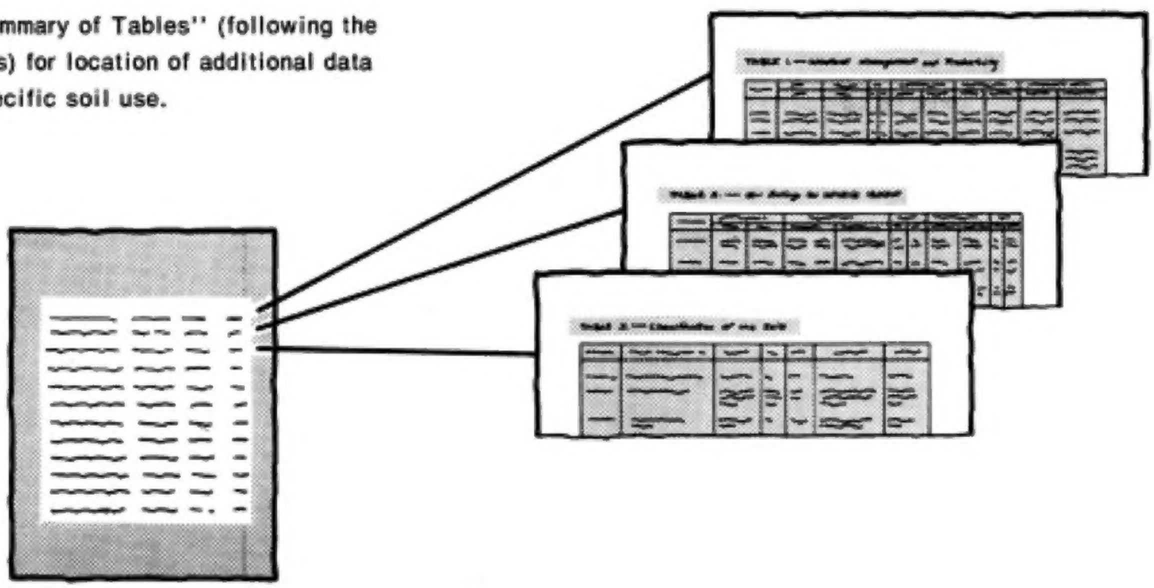


THIS SOIL SURVEY

5. Turn to "Index to Soil Map Units" which lists the name of each map unit and the page where that map unit is described.



6. See "Summary of Tables" (following the Contents) for location of additional data on a specific soil use.



7. Consult "Contents" for parts of the publication that will meet your specific needs. This survey contains useful information for farmers or ranchers, foresters or agronomists; for planners, community decision makers, engineers, developers, builders, or homebuyers; for conservationists, recreationists, teachers, or students; to specialists in wildlife management, waste disposal, or pollution control.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, state agencies including the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, handicap, or age.

Major fieldwork for this soil survey was completed in 1984. Soil names and descriptions were approved in 1985. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1984. The flight for the photo base map was in April 1976. This survey was made cooperatively by the Soil Conservation Service, the North Dakota Agricultural Experiment Station, the North Dakota Cooperative Extension Service, and the North Dakota State Soil Conservation Committee. Financial assistance was provided by the North Dakota Department of Universities and School Lands. The survey is part of the technical assistance furnished to the Kidder County Soil Conservation District.

Cover: A farmstead in an area of Towner and Embden soils. Stripcropping helps to control soil blowing in this area. Barnes and Svea soils are in the background. Photo courtesy of the North Dakota State Soil Conservation Committee.

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Soil Series

Issued March 1988

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Summary of Tables

Foreword

This soil survey contains information that can be used in land-planning programs in Kidder County. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, ranchers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to ensure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.

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Soil Survey of Kidder County, North Dakota

By Bruce Seelig and Alan R. Gulsvig, Soil Conservation Service

Fieldwork by David V. Wroblewski, Alan R. Gulsvig, Bruce Seelig, Clinton W. Tuve, Robert A. Hill, James F Strum, William Freymiller, and Steven W. Malakowsky, Soil Conservation Service, and Henry Jankoviak, North Dakota State Soil Conservation Committee

Map finishing by David W. Hickcox, North Dakota State Soil Conservation Committee

United States Department of Agriculture, Soil Conservation Service, in cooperation with North Dakota Agricultural Experiment Station, North Dakota Cooperative Extension Service, and North Dakota State Soil Conservation Committee

KIDDER COUNTY is in the south-central part of North Dakota (fig. 1). Steele, the county seat, is the largest town, having a population of 796. The county has a total area of 915,000 acres, or 1,430 square miles.

The county lies entirely in the Missouri Coteau part of the Missouri Plateau section of North Dakota and is in the Central Black Glaciated Plains land resource area of the Northern Great Plains and the Central Dark Brown Glaciated Plains (*15*). It is almost entirely in the drainage basin of the Missouri River. A small area in the northeast corner is drained by the James River drainage system.

There are no streams of any importance in the county, but lakes are numerous. Horsehead Lake, the largest of these, covers about 5,000 acres. Other lakes range from a few acres to several hundred acres in size. Many of the lakes are saline. Long Lake, in the southwest corner of the county, extends into Burleigh County (*10*).

Most of the central part of Kidder County consists of a level to steep, sandy and gravelly outwash plain that formed as glacial outwash coalesced and collapsed (*10*). The west-central and southwestern parts consist of an undulating to rolling glacial till plain that has medium textured soils. The rest of the county is largely steep moranic hills characterized by many small to large potholes and depressions (fig. 2). Most of the soils on the moranic hills are medium textured.

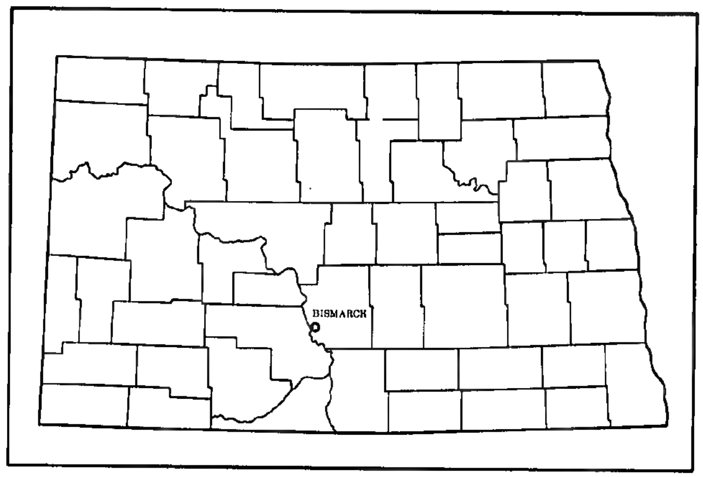

Figure 1.—Location of Kidder County in North Dakota.

A general soil map of Kidder County was published in 1963 and described in a report published in 1968 (*8*). The county also was included in a general soil map and report published in 1968 (*7*).

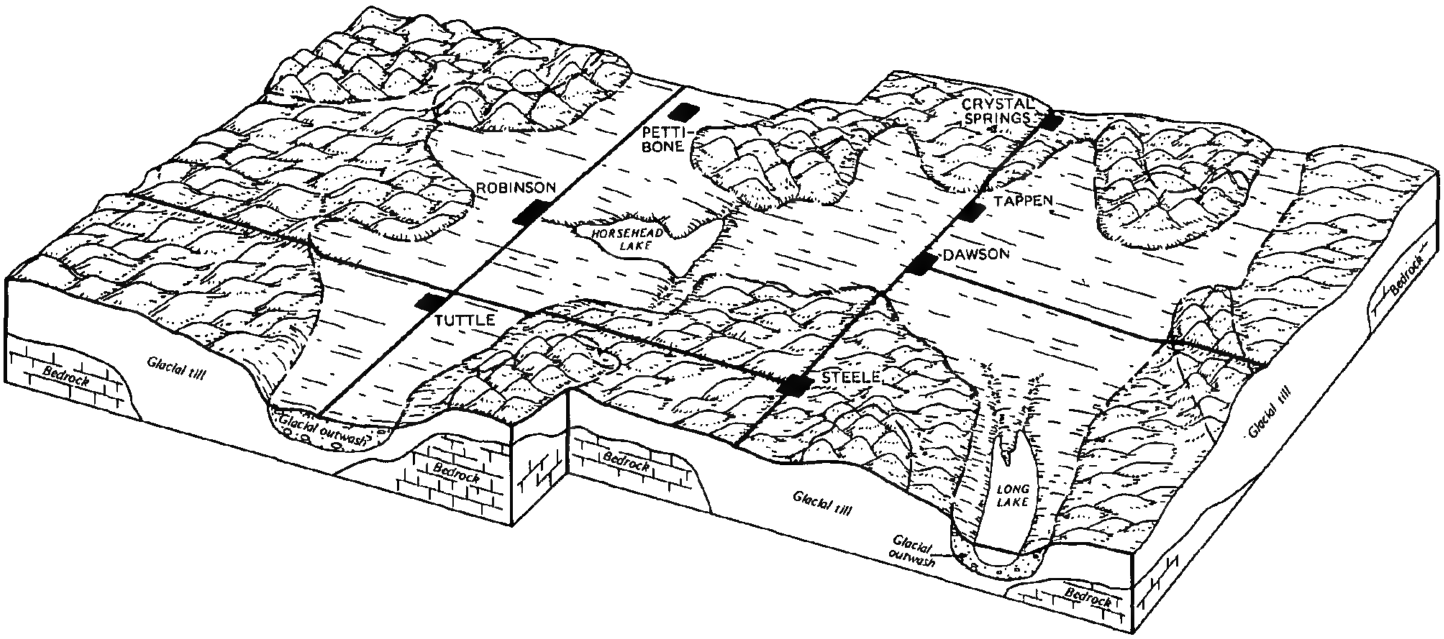

Figure 2.—Physiographic features of Kidder County.

General Nature of the County

This section provides general information about the county. It describes history and development, farming and ranching, natural resources, and climate.

History and Development

Prior to any permanent settlement in Kidder County, nomadic tribes of Indians roamed throughout the region, hunting the abundant game in the area. Apparently, there were no permanent camps. Evidence of teepee rings and artifacts suggest many temporary sites. Several battles between the Army and the Indians occurred between 1800 and 1875. The Indians were eventually pushed westward and settlement began shortly thereafter (*5, 9, 12*).

Kidder County was organized in 1881 and was named after Jefferson Kidder, an early settler and legislator in the Dakota Territory (*6*). Settlement began about a decade after the Northern Pacific Railroad reached the county in 1872. In 1881, Colonel Wilbur Steele plotted the town of Steele (*11*). At this time settlement of the southern part of the county was progressing, but the northern part was still sparsely settled, primarily by sheep herders and cattle ranchers. In the early 1900's, the Northern Pacific established a branch line in the northern part, thus stimulating settlement.

Most settlers obtained land under the Pre-emption Act and the Homestead Act and the subsequent Timber Culture Act. Railroad land was often sold at such low prices that many settlers preferred to buy land rather than conform to the laws that regulated homestead claims. Many settlers soon realized that the amount of land they could claim was not sufficient in many parts of the county, so they purchased additional holdings (*11*).

The population of Kidder County reached a high of just over 8,000 in the 1930's. It began to decrease in the 1930's because of the drought and depression. By 1980, it was about 3,833 (*6*).

Farming and Ranching

Agriculture in Kidder County is prosperous during years of adequate moisture. Interspersed between these years, however, are years of inadequate moisture (*8*). The cycles of inadequate moisture have resulted in more conservative land use patterns. From 1949 to 1978, the extent of summer fallow, pasture rotation, and hayland significantly increased.

The farm population of Kidder County decreased by 39 percent from 1950 to 1980. During this period, the number of farms decreased by 38 percent and the average size of the farms increased from 846 acres to 1,253 acres.

The county has always had a diverse agricultural base. Livestock production yields nearly the same income as small grain. The number of cow-calf operations increased from 1950 to 1974 and has somewhat declined since 1974. The number of dairy cows has

declined by nearly half, while dairy products continue to account for about 10 percent of the agricultural sales. The number of sheep increased from 1950 to 1959 but has decreased by more than two-thirds since 1959. The number of hogs has fluctuated in recent years. The number of chickens and turkeys has considerably decreased since 1950.

In recent years, the acreage of cropland has been approximately 421,000 acres and the acreage of native grassland approximately 275,000 acres. About 85,000 acres of the cropland is pasture. Alfalfa and alfalfa mixtures are the dominant hay crops. The yield of alfalfa averaged 1.5 tons per acre in 1982.

Most of the harvestable cropland is used for small grain, such as wheat, oats, barley, and rye. Wheat, which yields an average of 20.9 bushels per acre, has always been the dominant small grain. The second most common small grain is oats, which yields an average of 41.4 bushels per acre. The acreage planted to oats is less than half the acreage planted to wheat. A small acreage is planted to corn every year. Most of the corn is cut for silage. Flaxseed also is planted every year, but the acreage has decreased to only a small part of the cropland. The recent popularity of sunflowers, which yield an average of 1,100 pounds per acre, has contributed to the crop diversity in the county. Although not grown in significant amounts until the mid 1970's, sunflowers are now grown as extensively as oats.

As farming has become more intensive, the amount of fertilizer applied to the soils has increased. It nearly doubled from 1959 to 1978.

Sprinkler irrigation is becoming an acceptable alternative to dryland farming in some parts of Kidder County. In 1977, the North Dakota Water Commission reported 41 active permits for the irrigation of 16,110 acres in the county. In 1983, the Kidder County Agricultural Stabilization and Conservation Service reported that at least 7,080 acres has been developed for irrigation. The major irrigated crops are corn, alfalfa, and wheat.

Because of concern for the conservation of soil and water, the landowners of Kidder County organized a soil conservation district in 1937. The district at first included only eight townships, all of them around Steele. By 1947, it included the entire county. The Soil Conservation Service furnishes technical assistance to the district.

Natural Resources

The most important natural resource in Kidder County is the soil. Large amounts of sand and gravel, shallow ground water aquifers, and the surface water in the many potholes, lakes, and marshes also are important. The county has a large population of wildlife.

The livestock that graze the grassland and the crops grown on farms and ranches are marketable products that are affected by the soil. Mechanized agriculture has been easily adapted to the large areas of nearly level and undulating soils in the county. Approximately one-third of the county has good potential for irrigation.

The county probably has the greatest amount of ground water in the state. These aquifers are in the glacial outwash deposits, which cover approximately one-third of the county. These permeable deposits contain enough water to yield more than 100 gallons per minute in most wells. The wells used for irrigation commonly yield 750 to 1,000 gallons per minute. They are 60 to 100 feet deep. The quality of the water is good. Dissolved solids, principally calcium and sodium bicarbonate, range from 300 to 750 parts per million. The yields and quality of water from these aquifers are sufficient for ordinary farm and domestic uses and in places are adequate for irrigation.

The deposits of outwash sand and gravel have been used for road surfacing and construction. Even though the county has large quantities of this material, only one sizeable enterprise currently mines the sand and gravel.

Some studies have indicated the presence of possible oil reserves in the county. Only a few test wells for oil have been drilled.

Climate

Prepared by the National Climatic Center, Asheville, North Carolina.

Kidder County is usually quite warm in summer. Frequent spells of hot weather and occasional cool days characterize the summer. Temperatures are very cold in winter, when arctic air frequently surges over the area. Most precipitation falls during the warm period and is normally heaviest in late spring and early summer. Winter snowfall is normally not too heavy, and it is blown into drifts, so that much of the ground is free of snow.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Steele in the period 1951 to 1980. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 12 degrees F, and the average daily minimum temperature is 1 degree. The lowest temperature on record, which occurred at Steele on January 29, 1951, is -40 degrees. In summer the average temperature is 68 degrees, and the average daily maximum temperature is 82 degrees. The highest recorded temperature, which occurred at Steele on July 11, 1973, is 103 degrees.

Growing degree days are shown in table 1. They are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (40 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

The total annual precipitation is about 17 inches. Of this, about 14 inches, or nearly 80 percent, usually falls in April through September. The growing season for most crops falls within this period. In 2 years out of 10, the rainfall in April through September is less than 11 inches. The heaviest 1-day rainfall during the period of record was 3.38 inches at Steele on July 17, 1957 Thunderstorms occur on about 34 days each year.

The average seasonal snowfall is about 50 inches. The greatest snow depth at any one time during the period of record was 23 inches. On the average, 55 days of the year have at least 1 inch of snow on the ground. The number of such days varies greatly from year to year.

The average relative humidity in midafternoon is about 55 percent. Humidity is higher at night, and the average at dawn is about 80 percent. The sun shines 70 percent of the time possible in summer and 50 percent in winter. The prevailing wind is from the west-northwest. Average windspeed is highest, 12 miles per hour, in spring.

How This Survey Was Made

This survey was made to provide information about the soils in the survey area. The information includes a description of the soils and their location and a discussion of the suitability, limitations, and management of the soils for specified uses. Soil scientists observed the steepness, length, and shape of slopes; the general pattern of drainage; the kinds of crops and native plants growing on the soils; and the kinds of bedrock. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biologic activity.

The soils in the survey area occur in an orderly pattern that is related to the geology, the landforms, relief, climate, and the natural vegetation of the area. Each kind of soil is associated with a particular kind of landscape or with a segment of the landscape. By observing the soils in the survey area and relating their position to specific segments of the landscape, a soil scientist develops a concept, or model, of how the soils were formed. Thus, during mapping, this model enables the soil scientist to predict with considerable accuracy the kind of soil at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, alkalinity, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. The system of taxonomic classification used in the United States is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpreted the data from these analyses and tests as well as the field-observed characteristics and the soil properties in terms of expected behavior of the soils under different uses. Interpretations for all of the soils were field tested through observation of the soils in different uses under different levels of management. Some interpretations are modified to fit local conditions, and new interpretations sometimes are developed to meet local needs. Data were assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management were assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can state with a fairly high degree of probability that a given soil will have a high water table within certain depths in most years, but they cannot assure that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and coulees, all of which help in locating boundaries accurately.

Map Unit Composition

A map unit delineation on a soil map represents an area dominated by one major kind of soil or an area dominated by several kinds of soil. A map unit is identified and named according to the taxonomic classification of the dominant soil or soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural objects. In common with other natural objects, they have a characteristic variability in their properties. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of soils of other taxonomic classes. Consequently, every map unit is made up of the soil or soils for which it is named and some soils that belong to other taxonomic classes. These latter soils are called inclusions or included soils.

Most inclusions have properties and behavioral patterns similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting (similar) inclusions. They may or may not be mentioned in the map unit descriptions. Other inclusions, however, have properties and behavior divergent enough to affect use or require different management. These are contrasting (dissimilar) inclusions. They generally occupy small areas and cannot be shown separately on the soil maps because of the scale used in mapping. The inclusions of contrasting soils are mentioned in the map unit descriptions. A few inclusions may not have been observed and consequently are not mentioned in the descriptions, especially where the soil pattern was so complex that it was impractical to make enough observations to identify all of the kinds of soil on the landscape.

The presence of inclusions in a map unit in no way diminishes the usefulness or accuracy of the soil data. The objective of soil mapping is not to delineate pure taxonomic classes of soils but rather to separate the landscape into segments that have similar use and management requirements. The delineation of such landscape segments on the map provides sufficient information for the development of resource plans, but onsite investigation is needed to plan for intensive uses in small areas.

Survey Procedures

The general procedures used to make this survey are described in the Soil Conservation Service's National Soils Handbook and the *Soil Survey Manual* (*13*). *The Major Soils of North Dakota* (*7*), *Soil Taxonomy* (*14*), and *Land Resource Regions and Major Land Resource Areas of the United States* (*15*) were among the references used. The procedures used in determining the nature and characteristics of the soils are described under the heading "How This Survey Was Made."

Soil scientists traversed the land on foot and by pickup at an interval close enough for them to locate contrasting soil areas of about 3 to 5 acres. All map units were characterized by transects of representative areas. Generally, one transect was recorded for each 1,000 acres of a given map unit.

Data collected from the transects were used to determine soil names and establish the range of composition of each map unit. The statistical method explained by R.W. Arnold was used (*3*). This statistical analysis indicates that the map unit composition given in the map unit descriptions is at least 90 percent accurate.

Each soil map unit was documented by at least one pedon description for each soil series identified in its name. Laboratory data were collected in 1980 and 1981 on 12 pedons sampled for engineering properties. The analyses were made by the North Dakota State Highway Department. Nine of the pedons collected for analysis of engineering properties were analyzed by the North Dakota State University, Soil Characterization Laboratory.

During the course of the survey, access to a few areas was denied. Soil lines were extended through these areas on the basis of photo interpretation and knowledge of the soils in the surrounding area. The areas that were mapped in this way are as follows: SE1/4 sec. 20, S1/2 sec. 22, E1/2 sec. 28, W1/2 sec. 27, and E1/2 sec. 32, all in T. 137 N., R. 73 W.; sec. 19 and NW1/4 sec. 29, in T. 138 N., R. 73 W.; and sec. 8 and NW1/4 sec. 17, in T. 137 N., R. 72 W.

General Soil Map Units

The general soil map at the back of this publication shows the soil associations in this survey area. Each association has a distinctive pattern of soils, relief, and drainage. Each is a unique natural landscape. Typically, an association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in another but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one association differ from place to place in slope, depth, drainage, and other characteristics that affect management.

As a result of changes in series concepts, differing soil patterns, and differences in the design of the associations, some of the soil boundaries and soil names on the general soil map of this county do not match those on the general soil maps of Burleigh, Emmons, and Wells Counties.

Soil Descriptions

Nearly Level to Gently Rolling, Medium Textured Soils on Glacial Till Plains

These soils formed in till on glacial till plains. They make up about 15 percent of the county. They are used primarily for cultivated crops, but scattered areas are used as range. The soils are well suited to cultivated crops and to range. The main concerns in managing the soils for cultivated crops are water erosion and soil blowing. The principal limitations affecting building site development and septic tank absorption fields are moderately slow permeability and the shrink-swell potential.

1. Barnes-Svea-Buse Association

Deep, medium textured, nearly level to gently rolling, well drained and moderately well drained soils formed in glacial till

This association is on low ridges, side slopes, and foot slopes on till plains. Slopes are short and irregular. The landscape is dotted with depressions and light colored knolls and knobs. Slope ranges from 1 to 9 percent.

This association makes up about 5 percent of the county. It is about 40 percent Barnes soils, 17 percent Svea soils, 16 percent Buse soils, and 27 percent soils of minor extent.

The undulating and gently rolling, well drained Barnes soils are on the upper side slopes and the summits of ridges. Typically, they have a surface layer of black loam about 8 inches thick. The subsoil is loam about 24 inches thick. It is very dark brown in the upper part, dark grayish brown in the next part, and light yellowish brown and mottled in the lower part. The substratum to a depth of about 60 inches is dark grayish brown, mottled clay loam.

The nearly level and gently sloping, moderately well drained Svea soils are on foot slopes. Typically, they have a surface layer of black loam about 7 inches thick. The subsoil is about 36 inches thick. It is black loam in the upper part and dark grayish brown, mottled clay loam in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled clay loam.

The gently rolling, well drained Buse soils are on knolls, knobs, and shoulder slopes on ridges. Typically, they have a surface layer of very dark gray loam about 7 inches thick. The subsoil is grayish brown clay loam about 11 inches thick. The substratum to a depth of about 60 inches is light olive brown clay loam.

Hamerly, Nutley, and Parnell are the minor soils in this association. Hamerly soils are highly calcareous. They are on flats surrounding or adjacent to depressions. Nutley soils are on small glacial lake plains. They have a silty clay surface layer and subsoil. Parnell soils are very poorly drained and are in the depressions.

About 75 percent of this association is cultivated. The rest, generally the steeper areas, is used as range or pasture. The soils are suited to these uses. The hazards of soil blowing and water erosion are the main concerns in managing cultivated areas. The main concerns in managing range are maintaining the key range plants and preventing gullying along cattle trails. The light colored Buse soils on knolls and knobs are subject to soil blowing. The undulating and gently rolling areas are subject to water erosion. The minor Parnell soils are best suited to wetland wildlife habitat. The main concerns in managing wildlife habitat are preventing siltation and maintaining the natural water level.

2. Williams-Bowbells Association

Deep, medium textured, nearly level and undulating, well drained and moderately well drained soils formed in glacial till

This association is on side slopes, foot slopes, and ridges on till plains. The landscape is dotted with depressions and light colored knobs and knolls. Slope ranges from 1 to 6 percent.

This association makes up about 10 percent of the county. It is about 45 percent Williams soils, 25 percent Bowbells soils, and 30 percent soils of minor extent (fig. 3).

The well drained Williams soils are on side slopes and the summits of ridges. Typically, they have a surface layer of very dark brown loam about 7 inches thick. The subsoil is clay loam about 20 inches thick. It is dark grayish brown in the upper part and light olive brown in the lower part. The substratum to a depth of about 60 inches is grayish brown clay loam.

The moderately well drained Bowbells soils are on foot slopes. Typically, they have a surface soil of black loam about 13 inches thick. The subsoil is about 36 inches thick. It is very dark grayish brown clay loam in the upper part, very dark grayish brown loam in the next part, and grayish brown clay loam in the lower part. The substratum to a depth of about 60 inches is dark grayish brown clay loam.

Noonan, Parnell, and Zahl are the minor soils in this association. Noonan soils have a dense, alkali subsoil. They occur as areas intermingled with areas of the Williams soils. Parnell soils are very poorly drained and are in depressions. Zahl soils have a thin surface layer. They are on knobs and shoulder slopes on ridges.

Most of this association is cultivated. The rest is used as range. The soils are well suited to these uses. The hazards of water erosion and soil blowing are the main concerns in managing the cultivated areas. Maintenance of the key range plants and prevention of gullying along cattle trails are the main concerns in managing range. The undulating areas are subject to water erosion. The minor Zahl soils are subject to soil blowing. The minor Parnell soils are best suited to wetland wildlife habitat. The main concerns in managing wildlife habitat are preventing siltation and maintaining the natural water level.

Nearly Level to Rolling, Coarse Textured to Medium Textured Soils on Glacial Till Plains and Moraines

These soils formed in till and eolian sediments on glacial till plains. They make up about 11 percent of the county. They are used primarily for cultivated crops, but scattered areas are used as range. The soils are suited to cultivated crops and are well suited to range. The main concerns in managing the soils for cultivated crops are soil blowing, water erosion, and droughtiness. The

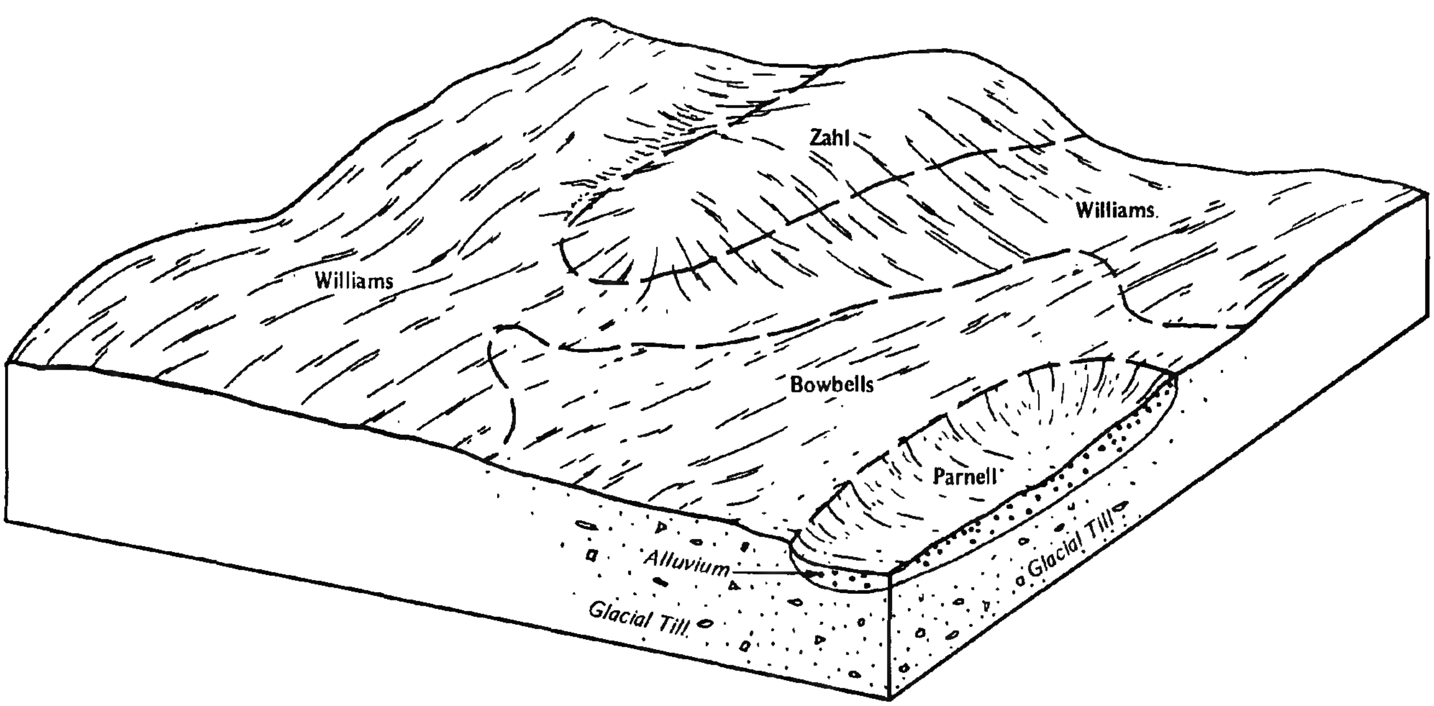

Figure 3.—Typical pattern of soils and parent material in the Williams-Bowbells association.

principal limitations affecting building site development and septic tank absorption fields are moderately slow or rapid permeability and the shrink-swell potential.

3. Barnes-Towner-Maddock Association

Deep, medium textured to coarse textured, nearly level to gently rolling, well drained and moderately well drained soils formed in glacial till and eolian sediments

This association is on foot slopes, flats, summits, hummocks, side slopes, and knolls on till plains mantled with eolian sediments. The landscape is dotted with swales and depressions. Slope ranges from 1 to 9 percent.

This association makes up about 6 percent of the county. It is about 25 percent Barnes soils, 22 percent Towner soils, 22 percent Maddock soils, and 31 percent soils of minor extent (fig. 4).

The well drained Barnes soils are on the sides and summits of ridges. Typically, they have a surface layer of black loam or sandy loam about 8 inches thick. The subsoil is loam about 24 inches thick. It is very dark brown in the upper part, dark grayish brown in the next part, and light yellowish brown and mottled in the lower part. The substratum to a depth of about 60 inches is dark grayish brown, mottled clay loam.

The moderately well drained Towner soils are on foot slopes and flats. Typically, they have a surface soil of black loamy fine sand about 18 inches thick. The subsoil is very dark grayish brown loamy sand about 15 inches thick. The upper part of the substratum is dark grayish brown, mottled clay loam. The lower part to a depth of about 60 inches is grayish brown, mottled loam.

The well drained Maddock soils are on flats, knolls, and hummocks. Typically, the surface soil is loamy fine sand about 16 inches thick. It is black in the upper part and very dark brown in the lower part. The subsoil is dark brown loamy fine sand about 3 inches thick. The substratum to a depth of about 60 inches is fine sand. It is brown in the upper part and dark grayish brown in the lower part.

Arvilla, Parnell, and Svea are the minor soils in this association. Arvilla soils have a coarse sand substratum. They are somewhat excessively drained and are on flats and knolls. Parnell soils are very poorly drained and are in depressions. Svea soils are dark to a depth of 16 inches or more. They are on foot slopes and are lower on the landscape than the Barnes soils.

About half of this association is cultivated, and half is used as range. The soils are suited to these uses. The hazards of soil blowing and drought are the main concerns in managing the cultivated areas. Maintaining the desirable kinds and amounts of native plants and controlling soil blowing are the main concerns in managing range.

4. Flaxton-Williams Association

Deep, medium textured and moderately coarse textured, nearly level to rolling, well drained soils formed in glacial till and eolian sediments

This association is on side slopes and in swales on till plains partially mantled with eolian sediments. The landscape is dotted with depressions and low knolls. Slope ranges from 1 to 15 percent.

This association makes up about 5 percent of the county. It is about 45 percent Flaxton soils, 15 percent Williams soils, and 40 percent soils of minor extent.

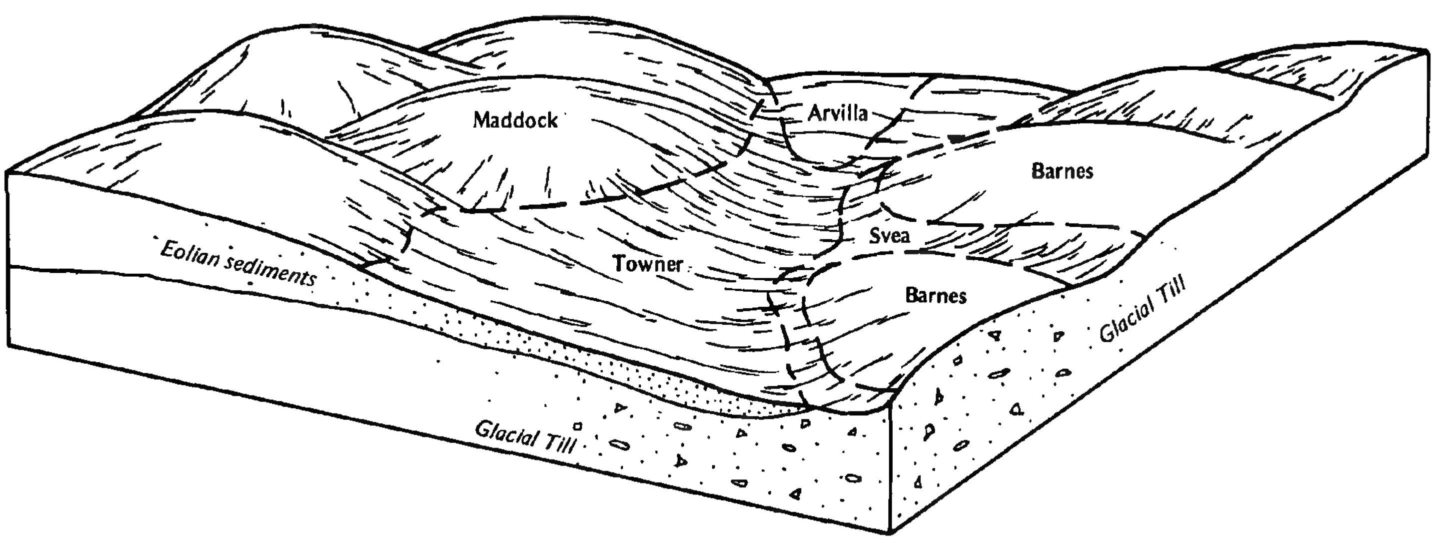

Figure 4.—Typical pattern of soils and parent material in the Barnes-Towner-Maddock association.

The nearly level to moderately sloping Flaxton soils are in swales and on side slopes. Typically, they have a surface layer of black fine sandy loam about 6 inches thick. The subsoil is about 40 inches thick. It is very dark grayish brown fine sandy loam in the upper part, very dark grayish brown sandy clay loam in the next part, and brown clay loam in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled loam.

The gently rolling and rolling Williams soils are on side slopes. Typically, they have a surface layer of very dark brown loam about 7 inches thick. The subsoil is clay loam about 20 inches thick. It is dark grayish brown in the upper part and light olive brown in the lower part. The substratum to a depth of about 60 inches is grayish brown clay loam.

Harriet, Parnell, and Zahl are the minor soils in this association. Harriet soils have a dense, alkali, saline subsoil. They are on flats. Parnell soils are very poorly drained and are in depressions. Zahl soils have a calcareous subsoil. They are on low knolls.

Most of this association is cultivated. The rest is used as range. The hazards of water erosion and soil blowing are the main concerns in managing the cultivated areas. Maintaining the desirable kinds and amounts of native plants and achieving a uniform distribution of grazing are the main concerns in managing range. The minor Zahl soils and the major Flaxton soils are subject to soil blowing if the protective plant cover is removed or depleted. The minor Parnell soils are best suited to wetland wildlife habitat. The main concerns in managing wildlife habitat are maintaining the natural water level and preventing siltation.

Nearly Level to Rolling, Moderately Coarse Textured Soils on Glacial Outwash Plains

These soils formed in outwash sediments on glacial outwash plains. They make up about 17 percent of the county. They are used primarily for cultivated crops, but scattered areas are used as range. The soils are poorly suited to cultivated crops and are well suited to range. The main concerns in managing the soils for cultivated crops are droughtiness and soil blowing. The principal limitations affecting building site development and septic tank absorption fields are rapid permeability and the instability of shallow excavations.

5. Arvilla Association

Deep, moderately coarse textured, nearly level to rolling, somewhat excessively drained soils formed in glacial outwash

This association is on flats, knolls, and low ridges on glacial outwash plains. The landscape is dotted with depressions and dissected by channels. Slope ranges from 1 to 15 percent.

This association makes up about 17 percent of the county. It is about 60 percent Arvilla soils and 40 percent soils of minor extent.

Typically, the surface layer of the Arvilla soils is very dark brown sandy loam about 8 inches thick. The subsoil is about 31 inches thick. It is very dark grayish brown sandy loam in the upper part, very dark grayish brown loamy sand in the next part, and dark grayish brown coarse sand in the lower part. The substratum to a depth of about 60 inches is grayish brown coarse sand.

Colvin, Divide, Maddock, and Sioux are the minor soils in this association. Colvin soils are poorly drained and are in depressions and channels. They are highly calcareous. Divide soils are somewhat poorly drained and are on flats surrounding the depressions. Maddock soils are well drained and are on low knolls and hummocks. Sioux soils have a very gravelly sand substratum. They occur as areas intermingled with areas of the Arvilla soils.

About 65 percent of this association is cultivated. The rest is used as range. The hazards of soil blowing and drought are the main concerns in managing the cultivated areas. Maintaining the desirable kinds and amounts of native plants and achieving a uniform distribution of grazing are the main concerns in managing range. The minor Colvin soils are best suited to wetland wildlife habitat and hay. The main concern in managing wildlife habitat is maintaining the natural wetness.

Level to Steep, Medium Textured and Moderately Fine Textured Soils on Glacial Till Plains and Moraines

These soils formed in till and alluvium on glacial till plains and moraines. They make up about 32 percent of the county. They are used primarily for range, but scattered areas are used for cultivated crops. The soils are well suited to range and are poorly suited to cultivated crops. The main concerns in managing range are maintaining the desirable kinds and amounts of native plants, preventing the denuding caused by overgrazing, and achieving a uniform distribution of grazing. The principal limitations affecting building site development and septic tank absorption fields are moderately slow permeability, slope, the shrink-swell potential, and wetness.

6. Barnes-Buse-Parnell Association

Deep, medium textured and moderately fine textured, level to steep, well drained and very poorly drained soils formed in glacial till and alluvium

This association is in depressions and on high knobs, knolls, and irregularly shaped ridges on till plains and moraines. Slope ranges from 0 to 35 percent.

This association makes up about 25 percent of the county. It is about 34 percent Barnes soils, 30 percent Buse soils, 9 percent Parnell soils, and 27 percent soils of minor extent (fig. 5).

The nearly level to hilly, well drained Barnes soils are on the sides and summits of knolls and ridges. Typically, they have a surface layer of black loam about 8 inches thick. The subsoil is loam about 24 inches thick. It is very dark brown in the upper part, dark grayish brown in the next part, and light yellowish brown and mottled in the lower part. The substratum to a depth of about 60 inches is dark grayish brown, mottled clay loam.

The gently rolling to steep, well drained Buse soils are on knolls, knobs, and shoulder slopes on ridges. Typically, they have a surface layer of very dark gray loam about 7 inches thick. The subsoil is grayish brown clay loam about 11 inches thick. The substratum to a depth of about 60 inches is light olive brown clay loam.

The level, very poorly drained Parnell soils are in depressions. Typically, they have a surface layer of black silty clay loam about 7 inches thick. The subsoil is silty clay about 35 inches thick. It is black in the upper part and very dark gray in the lower part. The substratum to a depth of about 60 inches is very dark gray silty clay.

Colvin, Hamerly, Sioux, and Svea are the minor soils in this association. The very poorly drained Colvin soils are on flats and in depressions. The somewhat poorly drained Hamerly soils are on flats surrounding the depressions. Colvin and Hamerly soils are highly calcareous. In some areas they are saline. The excessively drained Sioux soils are on ridges and knolls. They have a very gravelly sand substratum. The moderately well drained Svea soils are on foot slopes. They are dark to a depth of more than 16 inches.

Most areas of this association are used as range. Scattered areas, generally the undulating to hilly ones, are used for cultivated crops. The soils are well suited to range. The main concerns in managing range are maintaining the desirable kinds and amounts of native plants and achieving a uniform distribution of grazing. The main concerns in managing cropland are controlling water erosion and soil blowing. The Parnell soils are best suited to wetland wildlife habitat. The main concerns in managing wildlife habitat are preventing siltation and maintaining the natural water level.

7. Williams-Zahl Association

Deep, medium textured, gently rolling to steep, well drained soils formed in glacial till

This association is on knolls and ridges on till plains and moraines. The landscape is dotted with swales and depressions. Slope ranges from 6 to 35 percent.

This association makes up about 7 percent of the county. It is about 45 percent Williams soils, 20 percent Zahl soils, and 35 percent soils of minor extent.

The gently rolling to moderately steep, well drained Williams soils are on the sides and summits of ridges. Typically, they have a surface layer of very dark brown loam about 7 inches thick. The subsoil is clay loam about 20 inches thick. It is dark grayish brown in the

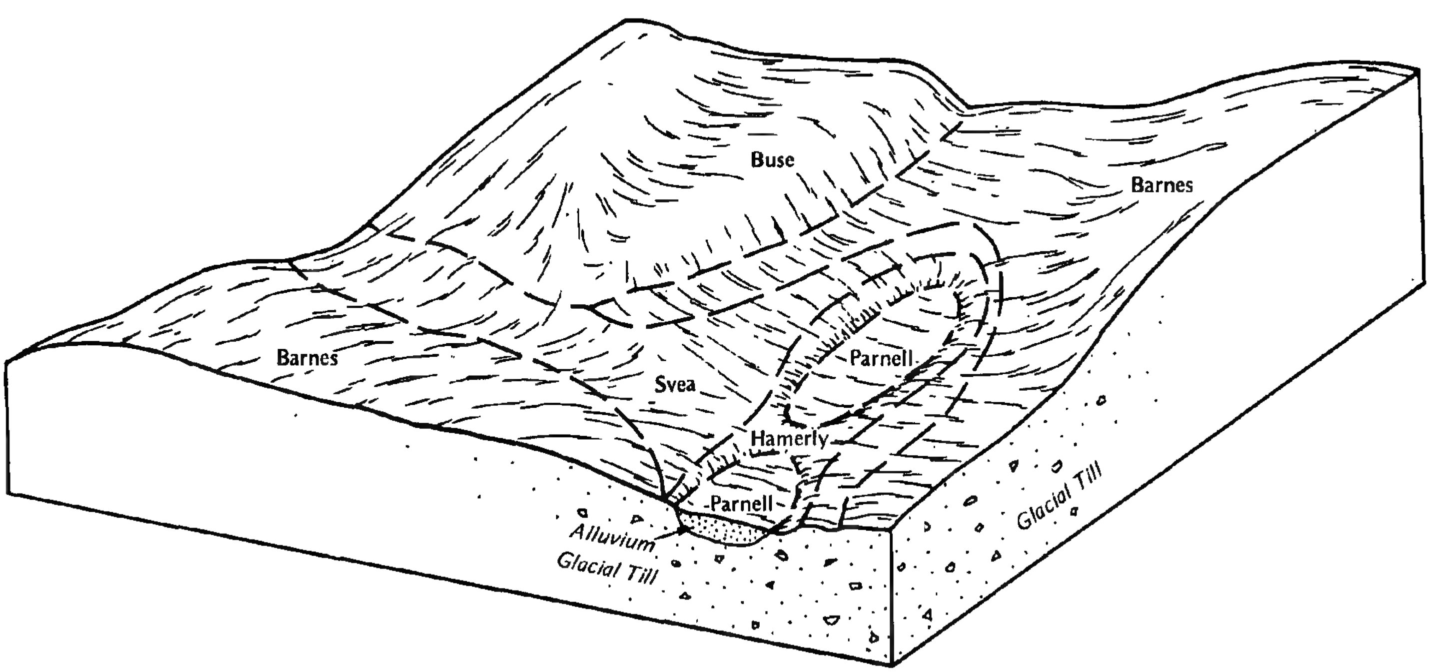

Figure 5.—Typical pattern of soils and parent material in the Barnes-Buse-Parnell association.

upper part and light olive brown in the lower part. The substratum to a depth of about 60 inches is grayish brown clay loam.

The gently rolling to steep, well drained Zahl soils are on knolls, knobs, and shoulder slopes on ridges. Typically, they have a surface layer of very dark brown loam about 6 inches thick. The subsoil is dark grayish brown, mottled clay loam about 20 inches thick. The substratum to a depth of about 60 inches is dark grayish brown, mottled clay loam.

Bowbells, Noonan, and Parnell are the minor soils in this association. The moderately well drained Bowbells soils are in swales. They are dark to a depth of 16 inches or more. The moderately well drained Noonan soils occur as areas intermingled with areas of the Williams soils. They have a dense, alkali subsoil. The very poorly drained Parnell soils are in depressions. They have a silty clay loam surface layer.

More than half of this association is used as range. Scattered areas, generally the undulating to rolling ones, are used for cultivated crops. The main concerns in managing cropland are controlling water erosion and soil blowing. The main concerns in managing range are maintaining the desirable kinds and amounts of native plants and achieving a uniform distribution of grazing. The minor Parnell soils are best suited to wetland wildlife habitat. The main concerns in managing wildlife habitat are preventing siltation and maintaining the natural water level.

Level to Steep, Coarse Textured to Medium Textured Soils on Coalesced and Collapsed Glacial Outwash Plains

These soils formed in glacial outwash and eolian sediments on outwash plains, some of which are dissected by glacial streams. The soils make up about 22 percent of the county. They are used dominantly for range or cultivated crops, but some areas are used as wildlife habitat. The soils are well suited to range and wildlife habitat and are poorly suited to cultivated crops. The principal concerns in managing range are controlling soil blowing, preventing the denuding caused by overgrazing, and maintaining the desirable kinds and amounts of native plants. The principal concerns in managing the cultivated areas are soil blowing and droughtiness.

The principal limitations affecting building site development are the wetness of the Hecla soils and the instability of shallow excavations, such as those for basements. The principal limitations affecting septic tank absorption fields are rapid permeability and the wetness of the Hecla soils.

8. Maddock-Hecla-Serden Association

Deep, coarse textured, nearly level to steep, well drained, moderately well drained, and excessively drained soils formed in glacial outwash and eolian sediments

This association is on dunes, hummocks, knolls, and flats on glacial outwash plains partially mantled with eolian sediments. The landscape is dotted with depressions, basins, and blowouts. Slope ranges from 1 to 35 percent.

This association makes up about 5 percent of the county. It is about 35 percent Maddock soils, 15 percent Hecla soils, 10 percent Serden soils, and 40 percent soils of minor extent (fig. 6).

The nearly level to gently rolling, well drained Maddock soils are on knolls and hummocks. Typically, the surface soil is loamy fine sand about 16 inches thick. It is black in the upper part and very dark brown in the lower part. The subsoil is dark brown fine sand about 3 inches thick. The substratum to a depth of about 60 inches is fine sand. It is brown in the upper part and dark grayish brown in the lower part.

The nearly level and undulating, moderately well drained Hecla soils are on flats and in swales below the Serden and Maddock soils. Typically, the surface soil is about 29 inches thick. It is black loamy fine sand in the upper part and very dark grayish brown loamy sand in the lower part. The next layer is very dark grayish brown, mottled loamy sand about 12 inches thick. The substratum to a depth of about 60 inches is brown loamy sand. It is mottled in the upper part.

The undulating to steep, excessively drained Serden soils are on knobs and ridges. Typically, they have a surface layer of very dark gray fine sand about 4 inches thick. The next layer is very dark grayish brown sand about 3 inches thick. The substratum to a depth of about 60 inches is dark grayish brown fine sand.

Arveson, Arvilla, Embden, and Towner are the minor soils in this association. The poorly drained Arveson soils are in basins and depressions. The somewhat excessively drained Arvilla soils are on flats and knolls. They have a coarse sand substratum. The moderately well drained Embden and Towner soils are in swales or on flats. Embden soils have a fine sandy loam surface layer and a fine sand substratum. Towner soils have a loamy fine sand surface layer and a loam or clay loam substratum.

Most areas of this association are used as range or wildlife habitat, but scattered small areas are used as cropland. The main concerns in managing range are maintaining the desirable kinds and amounts of native plants, preventing the denuding caused by overgrazing, controlling soil blowing, and achieving a uniform distribution of grazing. The main concerns in managing wildlife habitat are maintaining a diversity of plants for food and cover and controlling soil blowing. The main concerns in managing cultivated areas are controlling soil blowing and overcoming droughtiness.

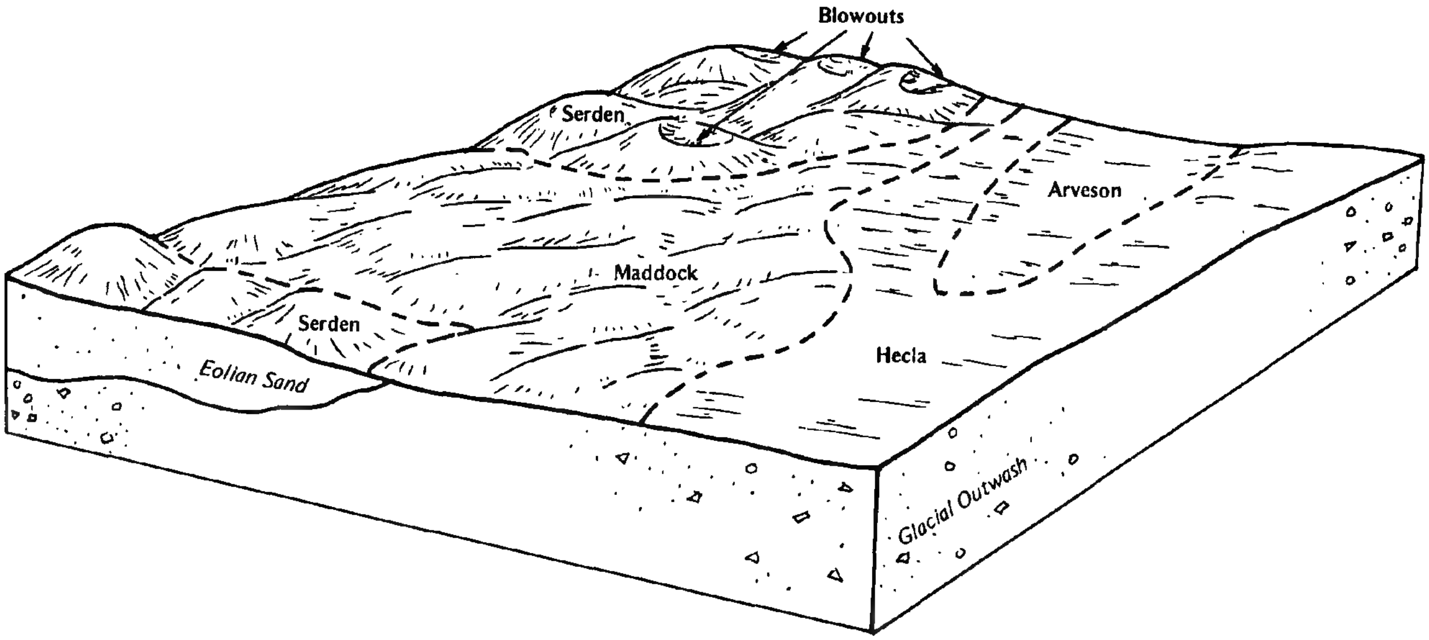

Figure 6.—Typical pattern of soils and parent material in the Maddock-Hecla-Serden association.

9. Sioux-Arvilla-Renshaw Association

Deep, medium textured and moderately coarse textured, level to steep, excessively drained and somewhat excessively drained soils formed in glacial outwash

This association is on ridges, knolls, and flats on dissected glacial outwash plains. The landscape is dotted with linear depressions and with swales. Slope ranges from 1 to 35 percent.

This association makes up about 17 percent of the county. It is about 30 percent Sioux soils, 15 percent Arvilla soils, 15 percent Renshaw soils, and 40 percent soils of minor extent.

The nearly level to steep, excessively drained Sioux soils are on ridges and knolls. Typically, they have a surface layer of black sandy loam about 7 inches thick. The next layer is dark grayish brown sandy loam about 5 inches thick. The substratum to a depth of about 60 inches is dark brown very gravelly sand.

The nearly level to rolling, somewhat excessively drained Arvilla soils are on ridges, knolls, and flats. Typically, they have a surface layer of very dark brown sandy loam about 8 inches thick. The subsoil is about 31 inches thick. It is very dark grayish brown sandy loam in the upper part, very dark grayish brown loamy sand in the next part, and dark grayish brown coarse sand in the lower part. The substratum to a depth of about 60 inches is grayish brown coarse sand.

The level to undulating, somewhat excessively drained Renshaw soils are on flats and the sides of knolls and knobs. Typically, they have a surface layer of black loam about 7 inches thick. The subsoil is about 11 inches thick. It is very dark brown loam in the upper part and dark brown gravelly coarse sand in the lower part. The substratum to a depth of about 60 inches is dark brown gravelly coarse sand.

Colvin, Divide, and Fordville are the minor soils in this association. The very poorly drained, highly calcareous Colvin soils are in depressions and swales. The somewhat poorly drained Divide soils are on flats surrounding the depressions. The well drained Fordville soils are on flats.

More than half of this association is cultivated. The rest is used as range. The main concerns in managing the cultivated areas are controlling soil blowing and overcoming the droughtiness. The main concerns in managing range are maintaining the desirable kinds and amounts of native plants and achieving a uniform distribution of grazing. The minor Colvin soils are best suited to wetland wildlife habitat and hay. The main concern in managing wildlife habitat is maintaining the natural wetness.

Level, Medium Textured to Coarse Textured Soils on Glacial Outwash Plains and Lake Plains

These soils formed in outwash and lacustrine sediments on glacial outwash plains and lake plains. They make up about 3 percent of the county. They are used primarily for range and wildlife habitat. They are unsuited to cultivated crops and well suited to range. The main concerns in managing the soils for range are

maintaining the desirable kinds and amounts of native plants and achieving a uniform distribution of grazing. A good plant cover helps to control soil blowing. The principal limitations affecting building site development and septic tank absorption fields are wetness, ponding, and rapid permeability.

10. Harriet-Minnewaukan-Stirum Association

Deep, medium textured to coarse textured, level, poorly drained soils formed in glacial outwash and lacustrine sediments

This association is on flats and in depressions surrounding lakes and smaller bodies of water on glacial outwash plains. Slope is 0 to 1 percent.

This association makes up about 3 percent of the county. It is about 35 percent Harriet soils, 20 percent Minnewaukan soils, 15 percent Stirum soils, and 30 percent soils of minor extent.

Harriet soils are on flats. Typically, they have a surface layer of very dark gray silt loam about 1 inch thick. The subsoil is very dark gray clay loam about 8 inches thick. The substratum to a depth of about 60 inches is olive gray, mottled clay loam.

Minnewaukan soils are on flats. Typically, they have a surface layer of very dark grayish brown sandy loam about 3 inches thick. The next layer is dark grayish brown, mottled loamy fine sand about 5 inches thick. The upper part of the substratum is olive, mottled loamy fine sand. The next part is olive, mottled fine sand. The lower part to a depth of about 60 inches is olive gray, mottled fine sand.

Stirum soils are in depressions and on flats. Typically, they have a surface layer of black loamy sand about 3 inches thick. The subsoil is sandy loam about 17 inches thick. It is very dark grayish brown in the upper part, gray in the next part, and gray and mottled in the lower part. The substratum to a depth of about 60 inches is mottled loamy sand. It is light gray in the upper part, olive in the next part, and olive gray in the lower part.

Arveson, Colvin, Hecla, Miranda, and Ulen are the minor soils in this association. Arveson, Colvin, and Ulen soils are highly calcareous. Arveson and Colvin soils are in depressions. Ulen soils occur as areas intermingled with areas of the Minnewaukan soils. Hecla soils are moderately well drained. They are on slight rises. Miranda soils have a dense, alkali subsoil. They are in the higher landscape positions.

Nearly all of this association is used as range. The hazard of soil blowing is severe. The main concerns in managing range are achieving a uniform distribution of grazing and maintaining the desirable kinds and amounts of native plants. Because of its proximity to bodies of water, this association is important as habitat for wetland wildlife. It provides cover and nesting areas for the wildlife. The main concern in managing wildlife habitat is maintaining a diversity of plants of sufficient height to provide cover.

Detailed Soil Map Units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and Management of the Soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer or of the substratum, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the substratum. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Buse loam, 9 to 15 percent slopes, is a phase in the Buse series.

Some map units are made up of two or more major soils. These map units are called soil complexes or undifferentiated groups.

A *soil complex* consists of two or more soils, or one or more soils and a miscellaneous area, in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Williams-Bowbells loams, 1 to 3 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils in the mapped areas are not uniform. An area can be made up of only one of the major soils, or it can be made up of all of them. Minnewaukan and Stirum soils is an undifferentiated group in this survey area.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description. Some small areas of strongly contrasting soils are identified by a special symbol on the soil maps.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of Tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

Soil Descriptions

2—Arveson loam, wet. This deep, level, very poorly drained, highly calcareous soil is in shallow basins and along drainageways on glacial outwash plains. It is subject to ponding. The landscape is characterized by microhummocks a few inches to 2 feet high. Individual areas range from 5 to more than 100 acres in size.

Typically, the surface layer is black loam about 8 inches thick. The subsoil is loam about 14 inches thick. It is dark gray in the upper part and grayish brown in the lower part. The substratum to a depth of about 60 inches is light olive brown, mottled loamy sand. In some places the surface layer is silt loam. In other places the soil contains more sand and less clay.

Included with this soil in mapping are small areas of Colvin and Hecla soils. These soils make up about 10 percent of the unit. Colvin soils are in swales. They have a silty clay loam substratum. Hecla soils are moderately well drained and are on slight rises. They have a loamy fine sand surface layer.

Permeability is moderately rapid in the Arveson soil, and runoff is ponded. Available water capacity is moderate. A seasonal high water table is 1 foot above the surface to 1 foot below. Organic matter content is high. Tilth is good.

Most areas are used as hayland or wetland wildlife habitat. This soil is well suited to these uses. If drained, it is suited to wheat, oats, barley, grasses, and legumes. Locating suitable drainage outlets generally is difficult.

As a result, few areas are drained. The wetness in undrained areas sometimes prevents tillage and seeding. The hazard of water erosion is slight, and the hazard of soil blowing is moderate. A system of conservation tillage that leaves plant residue on the surface and windbreaks help to control soil blowing. The soil and the ponded water provide feeding, breeding, and rearing areas for wetland wildlife. The main concerns in managing wildlife habitat are maintaining the natural wetness and preventing siltation.

The key range plants on this soil are big bluestem and indiangrass. Reed canarygrass and creeping foxtail are suitable hay and pasture plants. Compaction, trampling, and root shearing are hazards, especially if the range is grazed during wet periods. They can be overcome by deferring grazing when the soil is wet.

If drained, this soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas generally are unsuited to these uses. The wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on this soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and controlling the regrowth of this cover improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

This soil generally is unsuited to septic tank absorption fields and buildings because of the seasonal high water table and the ponding. Better sites generally are nearby.

The land capability classification is IIIw. The productivity index for spring wheat is 0 to 60, depending on the degree of drainage.

3—Marysland loam. This deep, level, poorly drained, highly calcareous soil is in shallow basins, swales, and drainageways on glacial outwash plains. It is underlain by gravelly coarse sand at a depth of about 37 inches. Individual areas range from about 5 to more than 80 acres in size.

Typically, the surface layer is loam about 7 inches thick. It is black in the upper part and very dark gray in the lower part. The subsoil is dark gray loam about 18 inches thick. The substratum to a depth of about 60 inches is olive gray. It is gravelly coarse sandy loam in the upper part and gravelly coarse sand in the lower part. In some places the substratum contains less sand and more clay. In other places the surface layer and subsoil are silt loam.

Included with this soil in mapping are small areas of Arvilla, Colvin, Fordville, and Sioux soils. These soils make up about 10 to 15 percent of the unit. The excessively drained Arvilla and well drained Fordville soils are higher on the landscape than the Marysland soil. They are not highly calcareous. Colvin soils are in the center of basins and drainageways. They have a silty clay loam substratum. The excessively drained Sioux soils are on low knobs. They are shallow to sand and gravel. Also included are some areas of the saline Colvin soils.

Permeability is moderate in the upper part of the Marysland soil and rapid in the lower part. Runoff is very slow. Available water capacity is moderate. A seasonal high water table is at a depth of 1.0 to 2.5 feet. Organic matter content is high. Tilth is good.

Most areas are used as hayland. If drained, this soil is suited to wheat, oats, barley, corn for silage, flax, grasses, and legumes. Locating suitable drainage outlets generally is difficult. As a result, few areas are drained. The wetness in undrained areas sometimes delays or prevents tillage and seeding. The hazard of water erosion is slight, and the hazard of soil blowing is moderate. A system of conservation tillage that leaves plant residue on the surface and windbreaks help to control soil blowing.

The key range plant on this soil is big bluestem. Smooth bromegrass, creeping foxtail, and reed canarygrass are suitable hay and pasture plants. No major hazards affect the use of this soil for range. Maintaining an adequate cover of the key plants helps to protect the surface.

If drained, this soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas generally are unsuited to these uses. The wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on this soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and controlling the regrowth of this cover improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

This soil generally is unsuited to septic tank absorption fields and buildings because of the seasonal high water table. Better sites generally are nearby.

The land capability classification is IIw. The productivity index for spring wheat is 0 to 60, depending on the degree of drainage.

5—Harriet silt loam. This deep, level, poorly drained, alkali soil is in shallow basins and drainageways. It is occasionally flooded. In areas of native grass, the surface is pitted with microdepressions or is barren in spots. Individual areas range from 5 to more than 400 acres in size.

Typically, the surface layer is very dark gray silt loam about 1 inch thick. The subsoil is very dark gray clay loam about 8 inches thick. The substratum to a depth of about 60 inches is olive gray, mottled clay loam. In some places the surface layer is loam, clay loam, or loamy sand. In other places the subsoil is less than 3 inches

thick. In a few areas the soil contains less sand and more silt throughout.

Included with this soil in mapping are small areas of Miranda, Stirum, Towner, and Williams soils. These soils make up about 10 to 15 percent of the unit. They are higher on the landscape than the Harriet soil. Miranda soils are moderately well drained. Stirum soils contain more sand in the subsoil and substratum than the Harriet soil. Towner and Williams soils do not have a dense, alkali subsoil. Williams soils are well drained, and Towner soils are moderately well drained. Also included are some areas of strongly saline soils.

Permeability is slow in the Harriet soil. Runoff also is slow. Available water capacity is moderate. The salts in the soil reduce the amount of water available to plants. A seasonal high water table is at the surface to 1 foot below the surface. Organic matter content is moderate.

Most areas are used as range. Because of the salinity and the wetness, this soil is generally unsuited to wheat, oats, and barley, to trees and shrubs, and to tame grasses and legumes for hay and pasture. It is best suited to range. The key native plants are nuttall alkaligrass and western wheatgrass. The high content of salts, the restricted amount of available water, compaction, trampling, and root shearing are limitations, especially if the range is grazed when the soil is wet. They can be overcome by maintaining adequate amounts of the key salt-tolerant plants and by deferring grazing when the soil is wet. Stock water ponds constructed in areas of this soil frequently contain salty water.

This soil generally is unsuited to septic tank absorption fields and buildings because of the high water table, the flooding, and the slow permeability. Better sites generally are nearby.

The land capability classification is VIs. The productivity index for spring wheat is 0.

7—Arveson-Ulen complex, 0 to 3 percent slopes. These deep, level and nearly level, highly calcareous soils are on glacial outwash plains. The poorly drained Arveson soil is in depressions. The somewhat poorly drained Ulen soil is on slight rises surrounding the depressions. Individual areas range from about 10 to more than 80 acres in size. They are about 30 to 65 percent Arveson soil and 25 to 50 percent Ulen soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the surface soil of the Arveson soil is loam about 13 inches thick. It is black in the upper part and very dark gray in the lower part. The subsoil is about 29 inches thick. It is grayish brown and mottled. It is fine sandy loam in the upper part and loamy fine sand in the lower part. The substratum to a depth of about 60 inches is mottled fine sand. It is light brownish gray in the upper part and olive gray in the lower part. In some areas the loamy part of the profile is less than 20 inches thick.

Typically, the surface soil of the Ulen soil is loamy fine sand about 12 inches thick. It is black in the upper part and very dark gray in the lower part. The subsoil is about 26 inches thick. It is dark gray loamy fine sand in the upper part and olive fine sand in the lower part. The substratum to a depth of about 60 inches is olive, mottled fine sand.

Included with these soils in mapping are small areas of Arvilla, Colvin, Divide, Embden, and Hecla soils. These included soils make up about 5 to 25 percent of the unit. The somewhat excessively drained Arvilla and moderately well drained Embden and Hecla soils are on low rises. They are not highly calcareous. Colvin soils have a silty clay loam and clay loam substratum. Divide soils have a gravelly substratum. Colvin and Divide soils occur as areas intermingled with areas of the Arveson and Ulen soils.

Permeability is moderately rapid in the Arveson soil and rapid in the Ulen soil. Runoff is very slow on both soils. Available water capacity is moderate. A seasonal high water table is at a depth of 1.0 to 2.0 feet in the Arveson soil and 2.5 to 6.0 feet in the Ulen soil. Organic matter content is high in the Arveson soil and moderately low in the Ulen soil. Tilth is good in both soils.

Most areas are used for hay or cultivated crops. The Ulen soil is suited to wheat, oats, barley, flax, corn for silage, grasses, and legumes. If drained, the Arveson soil also is suited. Locating suitable drainage outlets is generally difficult. As a result, few areas are drained. The wetness in the undrained Arveson soil usually delays and sometimes prevents tillage and seeding, but the Ulen soil is tilled and seeded at the normal time. The hazard of water erosion is slight, and the hazard of soil blowing is severe. A system of conservation tillage that leaves plant residue on the surface and windbreaks help to control soil blowing.

The key range plants on these soils are big bluestem, little bluestem, and switchgrass. Crested and intermediate wheatgrass, smooth bromegrass, and alfalfa are suitable hay and pasture plants. No major hazards affect the use of these soils for range. Maintaining an adequate cover of the key plants helps to protect the surface.

The Ulen soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. If drained, the Arveson soil also is suited. Undrained areas generally are unsuited to these uses. The wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on these soils are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and controlling the regrowth of this cover improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

These soils are generally unsuited to septic tank absorption fields and buildings because of the seasonal high water table. Better sites generally are nearby.

The land capability classification of the Arveson soil is IIw, and that of the Ulen soil is IVe. The productivity index of both soils for spring wheat is 42.

10—Minnewaukan and Stirum soils. These deep, level, poorly drained soils are in basins on glacial outwash plains. They commonly are adjacent to lakes and ponds. The Stirum soil is subject to ponding. Any one area can consist of all Minnewaukan soil, all the alkali Stirum soil, or any combination of both soils. Individual areas range from about 50 to more than 300 acres in size.

Typically, the Minnewaukan soil has a very dark grayish brown sandy loam surface layer about 3 inches thick. The next layer is dark grayish brown, mottled loamy fine sand about 5 inches thick. The substratum is mottled. The upper part is olive loamy fine sand. The next part is olive fine sand. The lower part to a depth of about 60 inches is olive gray fine sand. In some areas the surface layer is silt loam or loamy sand.

Typically, the Stirum soil has a black loamy sand surface layer about 3 inches thick. The subsoil is sandy loam about 17 inches thick. It is very dark grayish brown in the upper part, gray in the next part, and gray and mottled in the lower part. The substratum to a depth of about 60 inches is mottled loamy sand. It is light gray in the upper part, olive in the next part, and olive gray in the lower part.

Included with these soils in mapping are small areas of Arveson, Harriet, and Marysland soils. These included soils make up about 5 to 20 percent of the unit. Arveson soils are highly calcareous. Harriet soils have a clay loam subsoil and substratum. Marysland soils are gravelly coarse sand in the lower part of the substratum. All of the included soils occur as areas intermingled with areas of the Minnewaukan and Stirum soils.

Permeability is rapid in the Minnewaukan soil. It is moderately slow in the upper part of the Stirum soil and rapid in the lower part. Runoff is slow on the Minnewaukan soil and ponded on the Stirum soil. Available water capacity is low in both soils. A seasonal high water table is at the surface to 2.5 feet below the surface of the Minnewaukan soil and 0.5 foot above to 1.0 foot below the surface of the Stirum soil. Organic matter content is moderate in both soils. The dense, alkali subsoil of the Stirum soil restricts root development.

Most areas are used as range or wildlife habitat. Because of the salinity, the alkalinity, and a severe hazard of soil blowing, these soils are very poorly suited to wheat, oats, and barley and to tame grasses and legumes for hay and pasture. They are best suited to range and wildlife habitat. The key native plants are big bluestem and switchgrass. No major hazards affect the use of these soils for range. If the range is overgrazed, however, soil blowing is a hazard. It can be controlled by maintaining an adequate cover of the key plants.

If drained, the Minnewaukan soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas generally are unsuited to these uses. The wetness is a critical limitation affecting survival, growth, and vigor. The Stirum soil is suited to only a few of the drought- and salt-tolerant trees and shrubs. The grasses and weeds growing on the Minnewaukan soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and controlling the regrowth of this cover improve the survival and growth rates of the seedlings. Individual trees and shrubs growing on the Stirum soil vary in height, density, and vigor, which are affected by the restricted root development in the dense, alkali subsoil and the reduced amount of available water resulting from the salts in the soil. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

These soils generally are unsuited to septic tank absorption fields and buildings because of the ponding and the seasonal high water table. Better sites generally are nearby.

The land capability classification of the Minnewaukan soil is IVw, and that of the Stirum soil is VIs. The productivity index of both soils for spring wheat is 0 to 40, depending on the degree of drainage.

14—Tonka loam. This deep, level, poorly drained soil is in shallow depressions on glacial till plains. It is subject to ponding. Individual areas range from about 5 to 15 acres in size.

Typically, the surface layer is black loam about 8 inches thick. The subsurface layer is very dark grayish brown, mottled silt loam about 8 inches thick. The subsoil is about 37 inches thick. It is very dark grayish brown, mottled clay loam in the upper part; very dark grayish brown silty clay loam in the next part; and grayish brown, mottled silty clay loam in the lower part. The substratum to a depth of about 60 inches is olive gray, mottled clay loam. In some areas the surface layer is silt loam.

Included with this soil in mapping are small areas of Hamerly and Parnell soils. These soils make up about 5 to 10 percent of the unit. Hamerly soils are on the rims of depressions. They are somewhat poorly drained and highly calcareous. Parnell soils are in the lower part of the depressions. They have a silty clay loam surface layer.

Permeability is slow in the Tonka soil, and runoff is ponded. Available water capacity is high. A seasonal high water table is 0.5 foot above the surface to 1.0 foot below. Organic matter content is high. Tilth is good.

If drained, this soil is suited to wheat, oats, barley, flax, corn for silage, grasses, and legumes. Locating suitable drainage outlets generally is difficult. As a result, few areas are drained. The wetness in undrained areas delays tillage and seeding in most years and prevents them in some years. The hazards of water erosion and soil blowing are slight. A system of conservation tillage that leaves plant residue on the surface helps to control erosion.

Most areas are used as wetland wildlife habitat or range. The soil and the ponded water provide an early season breeding site and a good source of invertebrate protein for wetland wildlife. The main concerns in managing wildlife habitat are maintaining the natural wetness and preventing siltation.

The key range plants on this soil are slim sedge, wooly sedge, and prairie cordgrass. Creeping foxtail, reed canarygrass, and smooth bromegrass are suitable hay and pasture plants. Compaction, trampling, and root shearing are hazards, especially if the range is grazed during wet periods. They can be overcome by deferring grazing when the soil is wet.

If drained, this soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas generally are unsuited to these uses. The wetness is a critical

Figure 7.—An area of Parnell silty clay loam used as hayland.

limitation affecting survival, growth, and vigor. The grasses and weeds growing on this soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and controlling the regrowth of this cover improve the survival and growth rates of the seedlings.

This soil generally is unsuited to septic tank absorption fields and buildings because of the seasonal high water table, the ponding, and the slow permeability. Better sites generally are nearby.

The land capability classification is IIw. The productivity index for spring wheat ranges from 40 to 85, depending on the degree of drainage.

15—Parnell silty clay loam. This deep, level, very poorly drained soil is in depressions on glacial till plains. It is subject to ponding. Individual areas range from 5 to about 20 acres in size.

Typically, the surface layer is black silty clay loam about 7 inches thick. The subsoil is silty clay about 35 inches thick. It is black in the upper part and very dark gray in the lower part. The substratum to a depth of about 60 inches is very dark gray silty clay. In some places the soil is dark to a depth of less than 24 inches. In other places it is clay throughout. In some areas it is calcareous within a depth of 10 inches.

Included with this soil in mapping are small areas of Colvin and Tonka soils, which make up 5 to 20 percent of the unit. Colvin soils are on flats surrounding the depressions. They are highly calcareous. Tonka soils are in the shallower part of the depressions. They have a light colored subsurface layer.

Permeability is slow in the Parnell soil, and runoff is ponded. Available water capacity is high. A seasonal high water table is 2 feet above to 2 feet below the surface. Organic matter content is high. Tilth is fair.

Most areas are used as hayland, range, or wetland wildlife habitat. This soil is well suited to these uses. If drained, it is suited to wheat, oats, barley, flax, corn for silage, grasses, and legumes. Locating suitable drainage outlets generally is difficult. As a result, few areas are drained. The wetness in undrained areas prevents tillage and seeding in most years. The hazards of soil blowing and water erosion are slight. The soil and the ponded water provide feeding, breeding, and rearing areas for wetland wildlife. The main concerns in managing wildlife habitat are maintaining the natural wetness and preventing siltation.

The key range plants on this soil are slough sedge and rivergrass. Creeping foxtail and reed canarygrass are suitable hay and pasture plants (fig. 7). Compaction, trampling, and root shearing are hazards, especially if the range is grazed during wet periods. They can be overcome by deferring grazing when the soil is wet.

If drained, this soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas generally are unsuited to these uses. The wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on this soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and controlling the regrowth of this cover improve the survival and growth rates of the seedlings.

This soil generally is unsuited to septic tank absorption fields and buildings because of the seasonal high water table, the ponding, and the slow permeability. Better sites generally are nearby.

The land capability classification is IIIw. The productivity index for spring wheat ranges from 0 to 75, depending on the degree of drainage.

16—Southam silty clay loam. This deep, level, very poorly drained soil is in depressions on glacial till plains. It is subject to ponding. Individual areas range from 5 to about 150 acres in size.

Typically, the surface soil is about 28 inches thick. It is black. It is silty clay loam in the upper part and clay loam in the lower part. The substratum to a depth of about 60 inches is very dark gray. It is loam in the upper part and clay loam in the lower part. In some areas a 2- to 10-inch organic mat is at the surface.

Included with this soil in mapping are small areas of Colvin, Hamerly, and Tonka soils. These soils make up about 5 to 10 percent of the unit. Colvin and Hamerly soils are highly calcareous. Colvin soils are on flats surrounding the depressions. Hamerly soils are somewhat poorly drained and are higher on the landscape than the Parnell soil. Tonka soils are poorly drained and in the shallower part of the depressions. They have a light colored subsurface layer.

Permeability is slow in the Southam soil, and runoff is ponded. Available water capacity is high. A seasonal high water table is 5 feet above to 1 foot below the surface. Organic matter content is high.

In most areas this soil is used for wetland wildlife habitat. It is best suited to this use. It generally is unsuited to cultivated crops, range, pasture, hay, and trees and shrubs because of wetness. The soil and the ponded water provide excellent winter cover for resident wildlife and high-quality feeding, breeding, and rearing areas for wetland wildlife. The main concerns in managing wildlife habitat are preventing siltation and maintaining the natural water level.

This soil generally is unsuited to septic tank absorption fields and buildings because of the seasonal high water table, the ponding, and the slow permeability. Better sites generally are nearby.

The land capability classification is VIIIw. The productivity index for spring wheat is 0.

17—Markey muck. This deep, level, very poorly drained soil is in glacial outwash channels. It is subject to ponding. The landscape is characterized by

microhummocks a few inches to about 2 feet high. Individual areas range from about 40 to several hundred acres in size.

Typically, the surface layer is black muck about 5 inches thick. The next layer is very dark grayish brown peat about 3 inches thick. Below this is black muck about 20 inches thick. The substratum to a depth of about 60 inches is dark greenish gray sand. In some places the organic material is more than 25 percent fiber when rubbed. In other places it extends to a depth of more than 51 inches. In a few areas it is less than 16 inches thick.

Included with this soil in mapping are a few small areas of Arveson soils. These soils make up about 5 to 10 percent of the unit. They have a loam surface layer. They occur as areas intermingled with areas of the Markey soil.

Permeability is moderately rapid in the Markey soil, and runoff is ponded. Available water capacity is very high. A seasonal high water table is 1 foot above to 1 foot below the surface. Organic matter content is very high.

In most areas this soil is used for wetland wildlife habitat. It is best suited to this use. It generally is unsuited to cultivated crops, range, trees and shrubs, pasture, and hay because of the ponding and the seasonal high water table. The soil and the ponded water provide excellent winter cover for resident wildlife and feeding, breeding, and rearing areas for wetland wildlife. The main concerns in managing wildlife habitat are maintaining the natural water level and preventing siltation.

This soil generally is unsuited to septic tank absorption fields and buildings because of the seasonal high water table and the ponding. Better sites generally are nearby.

The land capability classification is VIIw. The productivity index for spring wheat is 0.

19—Colvin silt loam, saline. This deep, level, poorly drained, highly calcareous, moderately saline soil is in drainageways, in shallow depressions, and on flats on glacial till plains and outwash plains. In some small areas the surface has a salt crust. Individual areas range from about 5 to 50 acres in size.

Typically, the surface soil is very dark gray silt loam about 13 inches thick. It contains salt crystals. The subsoil is dark gray silty clay loam about 30 inches thick. It is mottled below a depth of about 31 inches. The substratum to a depth of about 60 inches is dark gray, mottled silty clay loam. In some places the soil contains more sand. In other places the substratum is fine sand or gravelly sand.

Included with this soil in mapping are small areas of Divide, Harriet, Miranda, Parnell, and Ulen soils. These soils make up about 5 to 20 percent of the unit. The somewhat poorly drained, highly calcareous Divide and Ulen soils are on flats. Divide soils have gravelly coarse sand at a depth of 20 to 40 inches, and Ulen soils are sandy throughout. Harriet soils have a dense, alkali subsoil. They occur as areas intermingled with areas of the Colvin soil. The moderately well drained Miranda soils are on slight rises. They have a dense, alkali subsoil. The very poorly drained Parnell soils are in depressions. They have a silty clay subsoil.

Permeability is moderately slow in the Colvin soil, and runoff is very slow. Available water capacity is high. Salts reduce the amount of water available to plants. A seasonal high water table is at the surface to 2 feet below the surface. Organic matter content is high. Tilth is good.

Most areas are used for cultivated crops, hay, or pasture. This soil is best suited to hay, pasture, range, or wildlife habitat. It is poorly suited to cultivated crops because of wetness and salinity. The hazard of soil blowing is moderate. The hazard of water erosion is slight. In undrained areas wetness delays or prevents tillage and seeding in some years. Fallowing should be avoided because it can result in salt accumulation in the surface layer. A system of conservation tillage that leaves crop residue on the surface helps to control soil blowing.

The key native plants on this soil are western wheatgrass, alkali cordgrass, and slim sedge. Tall wheatgrass is a suitable hay or pasture plant. The high content of salts, the restricted amount of available water, compaction, trampling, and root shearing are limitations, especially if the range is grazed when the soil is wet. They can be overcome by maintaining adequate amounts of the key salt-tolerant plants and by deferring grazing when the soil is wet. Stock water ponds constructed in areas of this soil frequently contain salty water.

This soil is suited to only a few of the most salt tolerant climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Individual trees and shrubs vary in height, density, and vigor, which are affected by the reduced amount of available water resulting from the salts in the soil. Reducing the evaporation rate at the surface improves seedling survival. When the bare soil surface dries, salt-laden water tends to move to the surface. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

This soil is generally unsuited to septic tank absorption fields and buildings because of the seasonal high water table. Better sites generally are nearby.

The land capability classification is IIIs. The productivity index for spring wheat is 0 to 40, depending on the degree of drainage.

20—Colvin silt loam. This deep, level, very poorly drained, highly calcareous soil is in broad channels on glacial outwash plains and till plains. It is subject to

ponding. Individual areas range from about 10 to more than 100 acres in size.

Typically, the surface layer is very dark gray silt loam about 7 inches thick. The subsoil is silty clay loam about 35 inches thick. It is dark gray in the upper part and gray in the lower part. The substratum to a depth of about 60 inches is dark olive gray, mottled clay loam. In some places the surface layer is silty clay loam. In other places the soil contains less silt and more sand or clay throughout.

Included with this soil in mapping are small areas of Arveson, Marysland, and Parnell soils. These soils make up about 5 to 20 percent of the unit. Arveson soils have a loam surface layer. They are in depressions. Marysland soils are gravelly coarse sand in the lower part of the substratum. They occur as areas intermingled with areas of the Colvin soil. Parnell soils have a silty clay subsoil. They are in depressions.

Permeability is moderately slow in the Colvin soil, and runoff is ponded. Available water capacity is high. A seasonal high water table is 1 foot above the surface to 1 foot below. Organic matter content is high. Tilth is good.

Most areas are used for hay or pasture. This soil is well suited to these uses. If drained, it is suited to wheat, oats, barley, flax, grasses, and legumes. Locating suitable drainage outlets generally is difficult. As a result, few areas are drained. The wetness in undrained areas sometimes delays or prevents tillage and seeding. The hazard of soil blowing is moderate, and the hazard of water erosion is slight. A system of conservation tillage that leaves plant residue on the surface and windbreaks help to control soil blowing. The soil and the ponded water provide early season breeding sites and a good supply of invertebrate protein for wetland wildlife. The main concerns in managing wildlife habitat are maintaining the natural wetness and preventing siltation.

The key range plants on this soil are slim sedge, wooly sedge, slough sedge, and rivergrass. Creeping foxtail and reed canarygrass are suitable hay and pasture plants. Compaction, trampling, and root shearing are hazards, especially if the range is grazed during wet periods. They can be overcome by deferring grazing when the soil is wet.

If drained, this soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas generally are unsuited to these uses. The wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on this soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and controlling the regrowth of this cover improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

This soil is generally unsuited to septic tank absorption fields and buildings because of the seasonal high water table and the ponding. Better sites generally are nearby.

The land capability classification is IIIw. The productivity index for spring wheat is 0 to 60, depending on the degree of drainage.

21D—Buse loam, 9 to 15 percent slopes. This deep, rolling, well drained soil is on knobs, knolls, and ridges on glacial till plains that are dissected by shallow drainageways. Individual areas range from about 10 to more than 100 acres in size.

Typically, the surface layer is very dark gray loam about 7 inches thick. The subsoil is grayish brown loam about 11 inches thick. The substratum to a depth of about 60 inches is light olive brown clay loam. In some places the upper part of the subsoil has no lime. In other places the surface layer is lighter colored and is less than 7 inches thick.

Included with this soil in mapping are small areas of Parnell and Svea soils. These soils make up about 5 to 20 percent of the unit. Parnell soils are very poorly drained and are in depressions. They have a silty clay subsoil. Svea soils have a dark surface layer and a subsoil that is more than 16 inches thick. They are in swales.

Permeability is moderately slow in the Buse soil, and runoff is rapid. Available water capacity is high. Organic matter content is moderately low.

Most areas are used as range. Because of a severe hazard of water erosion and a moderate hazard of soil blowing, this soil generally is unsuited to wheat, oats, barley, and flax. It is best suited to range. The key range plants are little bluestem and needleandthread. Crested and intermediate wheatgrass, smooth bromegrass, and alfalfa are suitable hay and pasture plants. Soil blowing and water erosion can be controlled by maintaining an adequate cover of the key plants. Gullies can form along cattle trails. Cross fences that control the pattern of livestock traffic help to prevent gullying.

This soil is generally unsuited to the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Trees and shrubs can be grown to enhance esthetic effects or to improve wildlife habitat if special treatment is applied, such as hand planting or scalp planting.

This soil is suited to septic tank absorption fields and buildings. The moderately slow permeability is a limitation in septic tank absorption fields, but it can be overcome by enlarging the field. The shrink-swell potential is a limitation on building sites, but installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling. The slope is a limitation on sites for buildings and septic tank absorption fields. It can be overcome by designing the

buildings and absorption fields so that they conform to the natural slope of the land.

The land capability classification is VIe. The productivity index for spring wheat is 0.

22B—Barnes-Svea loams, 1 to 6 percent slopes. These deep, nearly level and undulating soils are on glacial till plains. The well drained Barnes soil is on side slopes and summits. The moderately well drained Svea soil is on foot slopes. Individual areas range from about 10 to more than 400 acres in size. They are about 45 to 70 percent Barnes soil and 20 to 40 percent Svea soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Barnes soil has a black loam surface layer about 8 inches thick. The subsoil is loam about 24 inches thick. It is very dark brown in the upper part, dark grayish brown in the next part, and light yellowish brown and mottled in the lower part. The substratum to a depth of about 60 inches is dark grayish brown, mottled clay loam. In some places a layer of accumulated clay is in the subsoil. In other places the surface layer is very dark brown.

Typically, the Svea soil has a black loam surface layer about 7 inches thick. The subsoil is about 36 inches thick. It is black loam in the upper part and dark grayish brown, mottled clay loam in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled clay loam. In some places the soil has a very dark brown surface layer and has a layer of accumulated clay in the subsoil. In other places it has less clay and more sand to a depth of about 30 inches.

Included with these soils in mapping are small areas of Buse, Cresbard, Hamerly, Parnell, Renshaw, and Tonka soils. These included soils make up about 5 to 20 percent of the unit. The well drained Buse soils are on knolls and shoulder slopes. They have a calcareous subsoil. The moderately well drained Cresbard soils are on foot slopes. They have a dense, alkali subsoil. The somewhat poorly drained, highly calcareous Hamerly soils are on flats below the Svea soil. The very poorly drained Parnell and poorly drained Tonka soils are in depressions. The somewhat excessively drained Renshaw soils are shallow to gravelly coarse sand. Renshaw soils occur as areas intermingled with areas of the Barnes and Svea soils.

Permeability is moderately slow in the Barnes and Svea soils. Runoff is medium on the Barnes soil and slow on the Svea soil. Available water capacity is high in both soils. A seasonal high water table is at a depth of 4 to 6 feet in the Svea soil. Organic matter content is high in both soils. Tilth is good.

Most areas are used for cultivated crops. These soils are suited to wheat, oats, barley, flax, corn for silage, grasses, and legumes. The hazard of soil blowing is slight, and the hazard of water erosion is moderate. A system of conservation tillage that leaves crop residue on the surface and stripcropping help to control water erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

The key range plants on these soils are western wheatgrass, green needlegrass, and big bluestem. Intermediate wheatgrass, smooth bromegrass, Russian wildrye, and alfalfa are suitable hay and pasture plants. No major hazards affect the use of these soils for range. Maintaining an adequate cover of the key plants helps to protect the surface.

The Barnes soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Svea soil is suited to all climatically adapted species. It has no critical limitations. Eliminating grasses and weeds before the trees and shrubs are planted and controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings.

These soils are suited to septic tank absorption fields and buildings. The moderately slow permeability is a limitation in septic tank absorption fields, but it can be overcome by enlarging the field. The seasonal high water table in the Svea soil also is a limitation, but it can be overcome by a mound system. The shrink-swell potential is a limitation on building sites, but installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling. The drainage system also helps to prevent seepage into basements.

The land capability classification is IIe. The productivity index for spring wheat is 81.

22C—Barnes-Buse loams, 6 to 9 percent slopes. These deep, gently rolling, well drained soils are on glacial till plains. The Barnes soil is on side slopes. The Buse soil is on knolls, ridges, and shoulder slopes. Individual areas range from about 10 to more than 500 acres in size. They are about 50 to 70 percent Barnes soil and 25 to 35 percent Buse soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Barnes soil has a black loam surface layer about 7 inches thick. The subsoil is dark grayish brown clay loam about 25 inches thick. The substratum to a depth of about 60 inches is dark grayish brown, mottled clay loam. In some places the dark color of the surface layer extends to a depth of more than 16 inches. In other places the soil has a layer of accumulated clay in the subsoil and has a very dark brown surface layer.

Typically, the Buse soil has a very dark gray loam surface layer about 7 inches thick. The subsoil is grayish brown loam about 11 inches thick. The substratum to a depth of about 60 inches is light olive brown clay loam. In some places the surface layer is lighter colored and is less than 7 inches thick. In other places it is gravelly loam.

Included with these soils in mapping are small areas of Cresbard, Embden, Hamerly, Parnell, and Sioux soils. These included soils make up about 5 to 20 percent of the unit. The moderately well drained Cresbard soils are on foot slopes. They have a dense, alkali subsoil. The moderately well drained Embden soils are in swales. They are dark sandy loam to a depth of about 30 inches. The somewhat poorly drained, highly calcareous Hamerly soils are on flats and the rims of depressions. The very poorly drained Parnell soils are in depressions. The excessively drained Sioux soils are on knolls and ridges. They are shallow to very gravelly sand. Also included are some stony areas.

Permeability is moderately slow in the Barnes and Buse soils, and runoff is rapid. Available water capacity is high. Organic matter content is high in the Barnes soil and moderately low in the Buse soil. Tilth is good in both soils.

Most areas are used for cultivated crops. These soils are suited to wheat, oats, barley, flax, grasses, and legumes. The hazard of water erosion is severe on both soils, and the hazard of soil blowing is moderate on the Buse soil. A system of conservation tillage that leaves crop residue on the surface and stripcropping help to control soil blowing and water erosion.

The key range plants on these soils are western wheatgrass, needleandthread, and little bluestem. Intermediate wheatgrass, smooth bromegrass, Russian wildrye, and alfalfa are suitable hay and pasture plants. Soil blowing and water erosion are hazards, especially if the range is overgrazed. They can be controlled by maintaining an adequate cover of the key plants. Gullies can form along cattle trails. Cross fences that control the pattern of livestock traffic help to prevent gullying.

The Barnes soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Buse soil is suited to only the most drought tolerant species. Optimum growth, survival, and vigor are unlikely on this soil. Eliminating grasses and weeds before the trees and shrubs are planted and controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. On the Buse soil, strips of an annual cover crop between the rows help to control soil blowing and protect the seedlings from abrasion.

These soils are suited to septic tank absorption fields and buildings. The moderately slow permeability is a limitation in septic tank absorption fields, but it can be overcome by enlarging the field. The shrink-swell potential is a limitation on building sites, but installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling.

The land capability classification of the Barnes soil is IIIe, and that of the Buse soil is IVe. The productivity index of both soils for spring wheat is 52.

24B—Cresbard-Barnes loams, 1 to 6 percent slopes. These deep, nearly level and undulating soils are on glacial till plains. The moderately well drained, alkali Cresbard soil is on the lower side slopes and on foot slopes. The well drained Barnes soil is on side slopes. Individual areas range from 5 to about 200 acres in size. They are about 55 to 65 percent Cresbard soil and 15 to 25 percent Barnes soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Cresbard soil has a black loam surface layer about 5 inches thick. The next layer is black clay loam about 5 inches thick. It has dark gray silt coatings. The upper part of the subsoil is black clay. The next part is very dark gray clay loam. The lower part to a depth of about 60 inches is very dark grayish brown clay loam. In some places the subsoil has strong columnar structure. In other places the surface layer is fine sandy loam.

Typically, the Barnes soil has a black loam surface layer about 8 inches thick. The subsoil is loam about 24 inches thick. The upper part is very dark brown, the next part is dark grayish brown, and the lower part is light yellowish brown and mottled. The substratum to a depth of about 60 inches is dark grayish brown, mottled clay loam. In some places the dark color of the surface layer extends to a depth of more than 16 inches. In other places a layer of accumulated clay is in the subsoil.

Included with these soils in mapping are small areas of Buse, Hamerly, Miranda, and Parnell soils. These included soils make up about 10 to 30 percent of the unit. The well drained Buse soils are on knobs and knolls. They have a calcareous subsoil. The somewhat poorly drained, highly calcareous Hamerly soils are on flats. The alkali Miranda soils have a layer of accumulated salt within a depth of 16 inches. They are lower on the landscape than the Cresbard and Barnes soils. The very poorly drained Parnell soils are in depressions.

Permeability is slow in the Cresbard soil and moderately slow in the Barnes soil. Runoff is medium on both soils. Available water capacity is high. Organic matter content is high in the Barnes soil and moderate in the Cresbard soil. Tilth is fair in both soils. The dense, alkali subsoil of the Cresbard soil restricts the depth to which roots can penetrate.

Most areas are used for cultivated crops or pasture. These soils are suited to wheat, oats, barley, flax, corn for silage, grasses, and legumes. The hazard of water erosion is moderate, and the hazard of soil blowing is slight. A system of conservation tillage that leaves crop residue on the surface and stripcropping help to control water erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Growing alfalfa and managing crop residue increase the infiltration rate, improve tilth, and increase the depth to which roots can penetrate in the dense, alkali subsoil of the Cresbard soil.

The key range plants on these soils are western wheatgrass and green needlegrass. Intermediate wheatgrass, smooth bromegrass, and alfalfa are suitable hay and pasture plants. Water erosion is a hazard, especially if the range is overgrazed. It can be controlled by maintaining an adequate cover of the key plants. Gullies can form along cattle trails. Cross fences that control the pattern of livestock traffic help to prevent gullying.

The Cresbard soil is suited to many of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Barnes soil is suited to nearly all climatically adapted species. Eliminating grasses and weeds before the trees and shrubs are planted and controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Individual trees and shrubs on the Cresbard soil vary in height, density, and vigor, which are affected by the restricted root development in the subsoil and the reduced amount of available water resulting from the salts in the soil.

These soils are suited to septic tank absorption fields and buildings. The Barnes soil is better suited than the Cresbard soil. The moderately slow or slow permeability is a limitation in septic tank absorption fields, but it can be overcome by enlarging the field. The shrink-swell potential is a limitation on building sites, but installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling.

The land capability classification of the Cresbard soil is IIIe, and that of the Barnes soil is IIe. The productivity index of both soils for spring wheat is 73.

28D—Buse-Svea loams, 3 to 15 percent slopes. These deep soils are on glacial till plains. The well drained, gently rolling and rolling Buse soil is on knobs and shoulder slopes. The moderately well drained, undulating Svea soil is in swales. Individual areas range from about 30 to more than 400 acres in size. They are 40 to 60 percent Buse soil and 35 to 50 percent Svea soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Buse soil has a black loam surface layer about 7 inches thick. The subsoil is grayish brown clay loam about 17 inches thick. The substratum to a depth of about 60 inches is olive brown loam. In some places the surface layer is lighter colored and is less than 7 inches thick. In other places it is gravelly loam.

Typically, the Svea soil has a black loam surface layer about 7 inches thick. The subsoil is about 36 inches thick. It is black loam in the upper part and dark grayish brown, mottled clay loam in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled clay loam. In some places the dark color of the surface layer extends to a depth of only 8 to 16 inches. In other places a layer of accumulated clay is in the subsoil.

Included with these soils in mapping are small areas of Cresbard, Hamerly, Parnell, Sioux, and Tonka soils. These included soils make up about 5 to 15 percent of the unit. Cresbard soils are on foot slopes. They have a dense, alkali subsoil. The somewhat poorly drained, highly calcareous Hamerly soils are on flats and on the rims of depressions. The very poorly drained Parnell and poorly drained Tonka soils are in the depressions. The excessively drained Sioux soils are on knobs. They are shallow to very gravelly sand. Also included are some stony and cobbly areas.

Permeability is moderately slow in the Buse and Svea soils. Runoff is rapid on the Buse soil and slow on the Svea soil. Available water capacity is high in both soils. A seasonal high water table is at a depth of 4 to 6 feet in the Svea soil. Organic matter content is high in the Svea soil and moderately low in the Buse soil. Tilth is good in both soils.

Some areas are used for cultivated crops. These soils are poorly suited to wheat, oats, and barley, mainly because of the slope. They are suited to grasses and legumes. The hazard of water erosion is severe on both soils, and the hazard of soil blowing is moderate on the Buse soil. A system of conservation tillage that leaves crop residue on the surface and windbreaks help to control erosion and soil blowing.

Most areas are used as range. These soils are well suited to this use. The key range plants are little bluestem, needlegrass, western wheatgrass, and green needlegrass. Intermediate wheatgrass, smooth bromegrass, Russian wildrye, and alfalfa are suitable hay and pasture plants. Soil blowing and water erosion are hazards, especially if the range is overgrazed. They can be controlled by maintaining an adequate cover of the key plants. Gullies can form along cattle trails. Cross fences that control the pattern of livestock traffic help to prevent gullying.

The Buse soil is suited to only the most drought tolerant climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Optimum growth, survival, and vigor are unlikely on this soil. The Svea soil is suited to all climatically adapted species. It has no critical limitations. Eliminating grasses and weeds before the trees and shrubs are planted and controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. On the Buse soil, strips of an annual cover crop between the rows help to control soil blowing and protect the seedlings from abrasion.

These soils are suited to septic tank absorption fields and buildings. The moderately slow permeability is a limitation in septic tank absorption fields, but it can be overcome by enlarging the field. The seasonal high water table in the Svea soil also is a limitation. It can be overcome by a mound system. The shrink-swell potential

is a limitation on building sites, but installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling. The drainage system also helps to prevent seepage into basements. If the steeper areas are used as building sites or septic tank absorption fields, the slope is a limitation. It can be overcome however, by designing the buildings and absorption fields so that they conform to the natural slope of the land.

The land capability classification of the Buse soil is IVe, and that of the Svea soil is IIe. The productivity index of both soils for spring wheat is 58.

29E—Barnes-Buse-Parnell complex, 0 to 35 percent slopes. These deep soils are on glacial till plains and moraines. The well drained, gently sloping to hilly Barnes soil is on side slopes. The well drained, gently rolling to steep Buse soil is on shoulder slopes, ridges, knobs, and knolls. The very poorly drained, level Parnell soil is in depressions. It is subject to ponding. Stones and boulders are on some of the hilly and steep shoulder slopes and convex side slopes and on the rims of some depressions. Individual areas range from about 20 to more than 1,000 acres in size. They are about 40 to 55 percent Barnes soil, 20 to 40 percent Buse soil, and 10 to 30 percent Parnell soil. The three soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Barnes soil has a black loam surface layer about 6 inches thick. The subsoil is loam about 25 inches thick. It is very dark grayish brown in the upper part, brown in the next part, and light olive brown in the lower part. The substratum to a depth of about 60 inches is light olive brown, mottled loam. In some areas the subsoil has a layer of accumulated clay.

Typically, the Buse soil has a black loam surface layer about 7 inches thick. The subsoil is grayish brown clay loam about 14 inches thick. The substratum to a depth of about 60 inches is light brownish gray clay loam. In some areas the surface layer is lighter colored and is less than 7 inches thick.

Typically, the Parnell soil has a black silty clay loam surface layer about 6 inches thick. The subsoil is about 25 inches thick. It is black silty clay loam in the upper part and very dark gray clay in the lower part. The substratum to a depth of about 60 inches is olive gray silty clay. In some places the soil has a subsurface layer. In other places it is calcareous within a depth of 10 inches.

Included with these soils in mapping are small areas of Colvin, Hamerly, Sioux, and Svea soils. These included soils make up about 5 to 10 percent of the unit. The very poorly drained Colvin soils are in the shallow parts of depressions and in drainageways. The somewhat poorly drained Hamerly soils are on flats, generally surrounding depressions. Colvin and Hamerly soils are highly calcareous. The excessively drained Sioux soils are on knobs and ridgetops. They are shallow to very gravelly sand. The moderately well drained Svea soils are on foot slopes. They are dark to a depth of more than 16 inches. Also included are some areas of the saline Colvin soils.

Permeability is moderately slow in the Barnes and Buse soils and slow in the Parnell soil. Runoff is rapid on the Barnes and Buse soils and ponded on the Parnell soil. Available water capacity is high in all three soils. A seasonal water table is 2 feet above to 2 feet below the surface of the Parnell soil. Organic matter content is high in the Barnes and Parnell soils and moderately low in the Buse soil.

In most areas these soils are used for range or wildlife habitat. They are best suited to these uses. They are generally unsuited to wheat, oats, and barley, mainly because of the slope. The hazard of water erosion is severe on the Barnes and Buse soils, and the hazard of soil blowing is moderate on the Buse soil.

The key native plants on these soils are western wheatgrass, green needlegrass, little bluestem, and needleandthread on the Barnes and Buse soils and slough sedge and rivergrass on the Parnell soil. Intermediate wheatgrass, smooth bromegrass, and alfalfa are suitable hay and pasture plants on the Barnes and Buse soils. Reed canarygrass is suited to the Parnell soil. This soil is subject to trampling, compaction, and root shearing if grazed when wet. Soil blowing and water erosion are hazards, especially if the range is overgrazed. Reestablishing vegetation is difficult in denuded areas. The slope limits the use of machinery. Maintaining an adequate cover of the key plants helps to control soil blowing and water erosion and prevent denuding.

The Parnell soil and the ponded water provide excellent winter cover for resident wildlife and feeding, breeding, and rearing areas for wetland wildlife. The main concerns in managing wildlife habitat are maintaining the natural water level and preventing siltation.

The gently sloping to rolling areas of the Barnes soil are suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The gently rolling areas of the Buse soil are suited only to the most drought tolerant species. The more sloping areas are generally unsuited. If the Parnell soil is drained, it is suited to all climatically adapted species. Eliminating grasses and weeds before the trees and shrubs are planted and controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. On the Buse soil, strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The Barnes and Buse soils are suited to septic tank absorption fields and buildings. The moderately slow permeability is a limitation in septic tank absorption

fields, but it can be overcome by enlarging the field. The shrink-swell potential is a limitation on building sites, but installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling. If the steeper areas are used as building sites or septic tank absorption fields, the slope is a limitation. It can be overcome, however, by designing the buildings and absorption fields so that they conform to the natural slope of the land.

The Parnell soil generally is unsuited to septic tank absorption fields and buildings because of the seasonal high water table, the ponding, and the slow permeability. The Barnes and Buse soils are better sites for these uses.

The land capability classification of the Barnes and Buse soils is VIe, and that of the Parnell soil is IIIw. The productivity index of all three soils for spring wheat is 0.

32—Overly silt loam, 0 to 3 percent slopes. This deep, level and nearly level, moderately well drained soil is on glacial lake plains. Individual areas range from about 10 to more than 75 acres in size.

Typically, the surface soil is black silt loam about 15 inches thick. The subsoil is about 35 inches thick. In sequence downward, it is very dark brown silt loam, very dark grayish brown silty clay loam, dark grayish brown silty clay loam, and dark yellowish brown silty clay loam. The substratum to a depth of about 60 inches is olive brown, mottled silty clay loam. In some areas the soil has a layer of accumulated clay in the subsoil.

Included with this soil in mapping are small areas of Barnes, Hamerly, and Nutley soils. These soils make up about 5 to 20 percent of the unit. Barnes soils have a loam surface layer and subsoil. They occur as areas intermingled with areas of the Overly soil. The somewhat poorly drained, highly calcareous Hamerly soils are on the rims around depressions. Nutley soils are silty clay throughout. They occur as areas intermingled with the areas of Overly soil.

Permeability is moderately slow in the Overly soil, and runoff is slow. Available water capacity and organic matter content are high. A seasonal high water table is at a depth of 4 to 6 feet. Tilth is good.

Most areas are used for cultivated crops. This soil is suited to wheat, oats, barley, flax, corn for silage, grasses, and legumes. The hazards of soil blowing and water erosion are slight. A system of conservation tillage that leaves crop residue on the surface helps to prevent excessive soil loss. It also helps to provide food and cover for resident and migratory wildlife.

The key range plant on this soil is western wheatgrass. Intermediate wheatgrass, smooth bromegrass, and alfalfa are suitable hay and pasture plants. No major hazards affect the use of this soil for range. Maintaining an adequate cover of the key plants helps to protect the surface.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It has no critical limitations. Eliminating the grasses and weeds before the trees and shrubs are planted and controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings.

This soil is suited to septic tank absorption fields and buildings. The moderately slow permeability is a limitation in septic tank absorption fields, but it can be overcome by enlarging the field. The seasonal high water table also is a limitation, but it can be overcome by a mound system. The shrink-swell potential is a limitation on building sites, but installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling. The drainage system also helps to prevent seepage into basements.

The land capability classification is IIc. The productivity index for spring wheat is 98.

35B—Towner-Embden, loamy substratum complex, 1 to 6 percent slopes. These deep, nearly level and undulating, moderately well drained soils are on glacial till plains and outwash plains mantled with eolian material. The Towner soil is on flats and slight rises. The Embden soil is in swales. Individual areas range from 5 to more than 400 acres in size. They are about 35 to 60 percent Towner soil and 25 to 60 percent Embden soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Towner soil has a black loamy fine sand surface soil about 18 inches thick. The subsoil is very dark grayish brown loamy sand about 15 inches thick. The upper part of the substratum is dark grayish brown, mottled clay loam. The lower part to a depth of about 60 inches is grayish brown, mottled loam. In some places the sandy upper part of the soil is more than 40 inches thick. In other places the soil is dark to a depth of only 8 to 16 inches.

Typically, the Embden soil has a black fine sandy loam surface soil about 22 inches thick. The subsoil is dark grayish brown fine sandy loam about 30 inches thick. The substratum to a depth of about 60 inches is grayish brown loam. In some places the surface soil and subsoil are sandy loam. In other places the substratum is loam or clay loam within a depth of 40 inches.

Included with these soils in mapping are small areas of Arveson, Arvilla, Barnes, Maddock, and Tonka soils. These included soils make up about 5 to 15 percent of the unit. Arveson soils are highly calcareous and are in shallow depressions. Arvilla soils have a coarse sand substratum. They occur as areas intermingled with areas of the Towner and Embden soils. Barnes soils have a loam surface layer and subsoil. They are slightly higher on the landscape than the Towner and Embden soils. Maddock soils have a fine sand substratum. They occur

Figure 8.—An area of Towner-Embden, loamy substratum complex, 1 to 6 percent slopes, used for smooth bromegrass and alfalfa hay.

as areas intermingled with areas of the Towner and Embden soils. The poorly drained Tonka soils are in depressions. They have a loam surface layer.

Permeability is rapid in the upper part of the Towner soil and moderately slow in the lower part. It is moderately rapid in the Embden soil. Runoff is slow on both soils. Available water capacity is moderate. A seasonal high water table is at a depth of 3 to 6 feet in the Towner soil and 4 to 6 feet in the Embden soil. Organic matter content is moderate in the Towner soil and high in the Embden soil. Tilth is good in both soils.

Most areas are used for pasture or range (fig. 8). Some are used for cultivated crops. These soils are suited to wheat, oats, barley, flax, grasses, and legumes. The hazard of soil blowing is severe, and the hazard of water erosion is slight. A system of conservation tillage that leaves crop residue on the surface, windbreaks, and stripcropping help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

The key range plants on these soils are prairie sandreed and needleandthread. Alfalfa, smooth bromegrass, and crested wheatgrass are suitable hay and pasture plants. Soil blowing and the moderate available water capacity are problems, especially if the range is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the key plants helps to control soil blowing and prevents denuding.

The Towner soil is suited to many of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Embden soil is suited to all climatically adapted species. It has no critical limitations. On the Towner soil, which is somewhat droughty, the trees and shrubs are commonly affected by moisture stress. Supplemental watering helps to ensure the survival of seedlings. Little benefit is derived from fallowing the season prior to planting because of the limited available water capacity. Eliminating grasses and weeds before the trees and shrubs are planted and controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

These soils are suited to septic tank absorption fields and buildings. The moderately slow permeability of the Towner soil is a limitation in septic tank absorption fields, but it can be overcome by enlarging the field. The seasonal high water table in both soils also is a limitation, but it can be overcome by a mound system. The shrink-swell potential of the Towner soil is a limitation on building sites, but installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling. The drainage system also helps to prevent seepage into basements. The sides of shallow excavations, such as those for basements, tend to cave in unless they are shored.

The land capability classification of the Towner soil is IVe, and that of the Embden soil is IIIe. The productivity index of both soils for spring wheat is 57.

35C—Towner-Barnes complex, 6 to 9 percent slopes. These deep, moderately sloping soils are on glacial till plains mantled with eolian material. The moderately well drained Towner soil is on foot slopes. The well drained Barnes soil is on side slopes. Individual areas range from about 10 to more than 300 acres in size. They are about 45 to 60 percent Towner soil and 20 to 50 percent Barnes soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Towner soil has a black loamy fine sand surface soil about 19 inches thick. The subsoil is dark brown loamy sand about 12 inches thick. The substratum to a depth of about 60 inches is dark grayish brown, mottled clay loam. In some places the surface layer is loamy sand. In other places the soil is dark to a depth of only 8 to 16 inches.

Typically, the Barnes soil has a black sandy loam surface layer about 8 inches thick. The subsoil is loam about 21 inches thick. It is dark yellowish brown in the upper part and yellowish brown in the lower part. The substratum to a depth of about 60 inches is yellowish brown loam. In some places the surface layer is loam or gravelly loam. In other places the subsoil is calcareous.

Included with these soils in mapping are small areas of Arveson, Embden, Maddock, Svea, and Tonka soils. These included soils make up about 5 to 15 percent of the unit. The poorly drained, highly calcareous Arveson soils have a fine sand substratum. They are in depressions. The moderately well drained Embden soils are sandy loam to a depth of about 30 inches. They are in swales. Maddock soils are sandy throughout. They occur as areas intermingled with areas of Towner and Barnes soils. The moderately well drained Svea soils are in swales. They have a loam surface layer and are dark to a depth of more than 16 inches. The poorly drained Tonka soils are in depressions. They have a loam surface layer.

Permeability is rapid in the upper part of the Towner soil and moderately slow in the lower part. It is moderately slow in the Barnes soil. Runoff is medium on both soils. Available water capacity is moderate in the Towner soil and high in the Barnes soil. A seasonal high water table is at a depth of 3 to 6 feet in the Towner soil. Organic matter content is moderately low in the Towner soil and high in the Barnes soil. Tilth is good in both soils.

In most areas these soils are used for pasture or range. They are best suited to these uses. Some areas are used for cultivated crops. Because the hazard of soil blowing is severe and the hazard of water erosion is moderate, the soils are poorly suited to wheat, oats, barley, and flax. A system of conservation tillage that leaves crop residue on the surface, stripcropping, and windbreaks help to prevent excessive soil loss. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

The key range plants on these soils are prairie sandreed, needleandthread, western wheatgrass, and green needlegrass. Alfalfa, crested and intermediate wheatgrass, and smooth bromegrass are suitable hay and pasture plants. Soil blowing and water erosion are hazards, especially if the range is overgrazed. Maintaining an adequate cover of the key plants helps to prevent excessive soil loss. Gullies can form along cattle trails. Cross fences that control the pattern of livestock traffic help to prevent gullying.

The Towner soil is suited to many of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Barnes soil is suited to nearly all of the climatically adapted species. On the Towner soil, which is droughty, the trees and shrubs are commonly affected by moisture stress. Supplemental watering helps to ensure the survival of seedlings. Little benefit is derived from fallowing the season prior to planting because of the moderate available water capacity. Eliminating grasses and weeds before the trees and shrubs are planted and controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

These soils are suited to septic tank absorption fields and buildings. The moderately slow permeability is a limitation in septic tank absorption fields, but it can be overcome by enlarging the field. The seasonal high water table in the Towner soil also is a limitation, but it can be overcome by a mound system. The shrink-swell potential is a limitation on building sites, but installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling. The drainage system also helps to prevent seepage into basements in the Towner soil. The sides of shallow

excavations in the Towner soil, such as those for basements, tend to cave in unless they are shored.

The land capability classification of the Towner soil is IVe, and that of the Barnes soil is IIIe. The productivity index of both soils for spring wheat is 46.

36B—Flaxton fine sandy loam, 1 to 6 percent slopes. This deep, nearly level and undulating, well drained soil is on glacial till plains mantled with eolian material. Individual areas range from 15 to more than 1,500 acres in size.

Typically, the surface layer is black fine sandy loam about 6 inches thick. The subsoil is about 40 inches thick. It is very dark grayish brown fine sandy loam in the upper part, very dark grayish brown sandy clay loam in the next part, and brown clay loam in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled loam. In some places the dark color of the surface layer extends to a depth of only 8 to 16 inches. In other places the surface layer and subsoil contain more sand.

Included with this soil in mapping are small areas of Miranda, Tonka, Williams, and Zahl soils. These soils make up about 5 to 25 percent of the unit. The moderately well drained Miranda soils are in drainageways. They have a dense, alkali subsoil and have salts within a depth of 16 inches. The poorly drained Tonka soils are in depressions. They have a loam surface layer. Williams soils are loam or clay loam in the upper part of the subsoil. They are slightly higher on the landscape than the Flaxton soil. Zahl soils are on knolls. They have a loam surface layer and a calcareous subsoil.

Permeability is moderately rapid in the upper part of the Flaxton soil and moderately slow in the lower part. Runoff is slow. Available water capacity and organic matter content are high. Tilth is good.

Most areas are used for cultivated crops. This soil is suited to wheat, oats, barley, flax, grasses, and legumes. The hazard of soil blowing is severe, and the hazard of water erosion is slight. A system of conservation tillage that leaves crop residue on the surface, windbreaks, and stripcropping help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

The key range plants on this soil are needleandthread and prairie sandreed. Crested wheatgrass, intermediate wheatgrass, pubescent wheatgrass, smooth bromegrass, and alfalfa are suitable hay and pasture plants. Soil blowing is a hazard, especially if the range is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the key plants helps to control soil blowing and prevent denuding.

This soil is suited to many of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

This soil is suited to septic tank absorption fields and buildings. The moderately slow permeability is a limitation in septic tank absorption fields, but it can be overcome by enlarging the field. The shrink-swell potential is a limitation on building sites, but installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling. The sides of shallow excavations, such as those for basements, tend to cave in unless they are shored.

The land capability classification is IIIe. The productivity index for spring wheat is 69.

37—Divide loam, 0 to 3 percent slopes. This deep, level and nearly level, somewhat poorly drained, highly calcareous soil is on flats and along drainageways on glacial outwash plains. It is underlain by gravelly coarse sand at a depth of about 26 inches. Individual areas range from about 5 to more than 150 acres in size.

Typically, the surface layer is very dark gray loam about 7 inches thick. The subsoil is dark gray loam about 19 inches thick. The substratum to a depth of about 60 inches is gravelly coarse sand. It is light olive brown in the upper part and olive brown in the lower part. In some places the surface layer is silt loam or sandy loam. In other places the depth to gravelly coarse sand is less than 20 or more than 40 inches.

Included with this soil in mapping are small areas of Arveson, Fordville, Hamerly, Renshaw, and Ulen soils. These soils make up about 5 to 30 percent of the unit. The very poorly drained Arveson soils have a fine sand substratum. They are in depressions and drainageways. Fordville and Renshaw soils are better drained than the Divide soil and are not highly calcareous. They are on rises. Hamerly soils are loam or clay loam throughout, and Ulen soils are sandy throughout. Both of these soils occur in areas intermingled with areas of the Divide soil.

Permeability is moderate in the upper part of the Divide soil and rapid in the lower part. Runoff is slow. Available water capacity is moderate. A seasonal high water table is at a depth of 2.5 to 5.0 feet. Organic matter content is high. Tilth is good.

Most areas are used for cultivated crops. This soil is suited to wheat, oats, barley, flax, grasses, and legumes. The hazard of soil blowing is moderate, and the hazard of water erosion is slight. A system of conservation tillage that leaves crop residue on the surface and windbreaks help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Wetness delays tillage and seeding in some years.

The key range plants on this soil are big bluestem and switchgrass. Crested wheatgrass, intermediate wheatgrass, pubescent wheatgrass, smooth bromegrass, and alfalfa are suitable hay and pasture plants. No major hazards affect the use of this soil for range. Maintaining an adequate cover of the key plants helps to protect the surface.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. No critical limitations affect the trees and shrubs. Eliminating grasses and weeds before the trees and shrubs are planted and controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

This soil is poorly suited to septic tank absorption fields because it has a seasonal high water table. It is suited to buildings, but the wetness is a limitation on sites for buildings with basements. In this survey area, Divide soils generally are not used as building sites or absorption fields. Better sites generally are nearby.

The land capability classification is IIIs. The productivity index for spring wheat is 64.

38D—Flaxton-Zahl complex, 6 to 12 percent slopes. These deep, well drained soils are on till plains, some of which are mantled with eolian material. The gently rolling Flaxton soil is on side slopes, and the gently rolling and rolling Zahl soil is on ridges and knolls. Individual areas range from about 30 to more than 150 acres in size. They are about 50 to 75 percent Flaxton soil and 20 to 40 percent Zahl soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Flaxton soil has a black fine sandy loam surface layer about 6 inches thick. The subsoil is about 40 inches thick. It is very dark grayish brown fine sandy loam in the upper part, very dark grayish brown sandy clay loam in the next part, and brown clay loam in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled loam.

Typically, the Zahl soil has a very dark brown loam surface layer about 8 inches thick. The subsoil is olive brown loam about 10 inches thick. The substratum to a depth of about 60 inches is light olive brown clay loam. In some places the surface layer is fine sandy loam or sandy loam. In other places a layer of accumulated clay is in the subsoil.

Included with these soils in mapping are small areas of Embden, Noonan, and Parnell soils. These included soils make up about 5 to 10 percent of the unit. Embden soils are sandy loam to a depth of about 30 inches. Noonan soils have a loam surface layer and a dense, alkali subsoil. Embden and Noonan soils are lower on the landscape than the Flasher and Zahl soils. The very poorly drained Parnell soils are in depressions. They have a silty clay loam surface layer.

Permeability is moderately rapid in the upper part of the Flaxton soil and moderately slow in the lower part. It is moderately slow in the Zahl soil. Runoff is medium on the Flaxton soil and rapid on the Zahl soil. Available water capacity is high in both soils. Organic matter content is moderate. Tilth is good.

In most areas these soils are used for range or hay. They are best suited to these uses. Some areas are used for cultivated crops. The soils are poorly suited to wheat, oats, and barley. The hazard of soil blowing is severe, and the hazard of water erosion is moderate. A system of conservation tillage that leaves crop residue on the surface, windbreaks, and stripcropping help to prevent excessive soil loss. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

The key range plants on these soils are prairie sandreed, needleandthread, and little bluestem. Alfalfa, crested wheatgrass, intermediate wheatgrass, and smooth bromegrass are suitable hay and pasture plants. Soil blowing and water erosion are hazards, especially if the range is overgrazed. They can be controlled by maintaining an adequate cover of the key plants. Gullies can form along cattle trails. Cross fences that control the pattern of livestock traffic help to prevent gullying.

The Flaxton soil is suited to many of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The gently rolling areas of the Zahl soil are suited to only the most drought tolerant species, and the more sloping areas are generally unsuited to any species. Optimum growth, survival, and vigor are unlikely on this soil. Eliminating grasses and weeds before the trees and shrubs are planted and controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows help to control soil blowing and protect the seedlings from abrasion.

These soils are suited to septic tank absorption fields and buildings. The moderately slow permeability is a limitation in septic tank absorption fields, but it can be overcome by enlarging the field. The shrink-swell potential is a limitation on building sites, but installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling. If the steeper areas are used as building sites or absorption fields, the slope is a limitation. It can be overcome, however, by designing the buildings and absorption fields so that they conform to the natural slope of the land. In areas of the Flaxton soil, the sides of shallow excavations, such as those for basements, tend to cave in unless they are shored.

The land capability classification of the Flaxton soil is IVe, and that of the Zahl soil is VIe. The productivity index of both soils for spring wheat is 42.

39—Embden fine sandy loam, 1 to 3 percent slopes. This deep, nearly level, moderately well drained soil is on glacial outwash plains. Individual areas range from 5 to more than 100 acres in size.

Typically, the surface soil is black fine sandy loam about 11 inches thick. The subsoil is about 42 inches thick. It is black fine sandy loam in the upper part, very dark grayish brown, mottled fine sandy loam in the next part, and brown, mottled loamy fine sand in the lower part. The substratum to a depth of about 60 inches is brown fine sand. In some areas the surface layer is loam or sandy loam.

Included with this soil in mapping are small areas of Arveson, Arvilla, Fordville, Maddock, and Towner soils. These soils make up about 5 to 30 percent of the unit. The poorly drained, highly calcareous Arveson soils are in depressions. The somewhat excessively drained Arvilla and well drained Maddock soils are on rises. Arvilla soils have a coarse sand substratum. Maddock soils have a loamy fine sand surface layer and subsoil. Fordville soils are loam in the surface layer and in the upper part of the subsoil. They occur as areas intermingled with areas of the Embden soil. Towner soils have a clay loam and loam substratum. They are higher on the landscape than the Embden soil.

Permeability is moderately rapid in the Embden soil, and runoff is slow. Available water capacity is moderate. A seasonal high water table is at a depth of 4 to 6 feet. Organic matter content is high. Tilth is good.

Most areas are used for cultivated crops or hay. This soil is suited to wheat, oats, barley, flax, grasses, and legumes. The hazard of soil blowing is severe, and the hazard of water erosion is slight. A system of conservation tillage that leaves crop residue on the surface, windbreaks, and stripcropping help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Leaving tall stubble on the surface helps to trap snow and thus increases the supply of soil moisture.

The key range plants on this soil are prairie sandreed and needleandthread. Wheatgrasses, smooth bromegrass, and alfalfa are suitable hay and pasture plants. Soil blowing and the moderate available water capacity are problems, especially if the range is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the key plants helps to control soil blowing and prevent denuding.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. No critical limitations affect the trees and shrubs. Eliminating grasses and weeds before the trees and shrubs are planted and controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

This soil is suited to septic tank absorption fields and buildings. The seasonal high water table is a limitation in septic tank absorption fields, but it can be overcome by a mound system. A surface and foundation drainage system helps to prevent seepage into basements. The sides of shallow excavations, such as those for basements, tend to cave in unless they are shored.

The land capability classification is IIIe. The productivity index for spring wheat is 70.

42B—Barnes-Sioux sandy loams, 3 to 9 percent slopes. These deep, undulating and gently rolling soils are on glacial outwash plains and till plains. The well drained Barnes soil is on side slopes. The excessively drained Sioux soil is on ridges, knolls, and knobs. Some of the ridges and knolls are stony. Individual areas range from about 10 to more than 50 acres in size. They are about 45 to 60 percent Barnes soil and 20 to 35 percent Sioux soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Barnes soil has a black sandy loam surface layer about 6 inches thick. The subsoil is loam about 28 inches thick. It is very dark grayish brown in the upper part and olive brown in the lower part. The substratum to a depth of about 60 inches is light olive brown loam. In some places the surface layer is gravelly loam or cobbly fine sandy loam. In other places a layer of accumulated clay is in the subsoil.

Typically, the Sioux soil has a black sandy loam surface layer about 8 inches thick. The next layer is dark brown gravelly sandy loam about 5 inches thick. The substratum to a depth of about 60 inches is very gravelly sand. It is brown in the upper part and dark yellowish brown in the lower part. In some places the surface layer is gravelly or cobbly loam. In other places the depth to gravelly sand is as much as 20 inches. In some areas the substratum is loam or clay loam below a depth of about 30 inches.

Included with these soils in mapping are small areas of Arvilla, Fordville, Hamerly, and Svea soils, which make up about 10 to 20 percent of the unit. The somewhat excessively drained Arvilla soils have a coarse sand substratum. They occur as areas intermingled with areas of the Sioux soil. The well drained Fordville soils have a loam surface layer and subsoil and a gravelly sand substratum. Fordville and Hamerly soils are on flats. The somewhat poorly drained, highly calcareous Hamerly soils and the moderately well drained Svea soils are loam or clay loam throughout. Svea soils are dark to a depth of more than 16 inches. They are in swales.

Permeability is moderately slow in the Barnes soil and very rapid in the Sioux soil. Runoff is medium on the Barnes soil and slow on the Sioux soil. Available water capacity is high in the Barnes soil and low in the Sioux

soil. Organic matter content is moderately low in the Sioux soil and high in the Barnes soil. Tilth is good in both soils.

Most areas are used for cultivated crops. These soils are suited to wheat, oats, barley, flax, corn for silage, grasses, and legumes. The hazard of soil blowing is severe, and the hazard of water erosion is moderate. The Sioux soil is droughty. A system of conservation tillage that leaves crop residue on the surface and stripcropping help to prevent excessive soil loss. Conservation tillage also helps to provide food and cover for migratory and resident wildlife.

The key range plants on these soils are needleandthread, western wheatgrass, and green needlegrass. Intermediate wheatgrass, smooth bromegrass, and alfalfa are suitable hay and pasture plants. Soil blowing, water erosion, and the low available water capacity of the Sioux soil are problems, especially if the range is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the key plants helps to control soil blowing and water erosion and prevent denuding. Gullies can form along cattle trails. Cross fences that control the pattern of livestock traffic help to prevent gullying.

The Barnes soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings, but the Sioux soil generally is unsuited. Eliminating grasses and weeds before the trees and shrubs are planted and controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows help to control soil blowing and protect the seedlings from abrasion.

The Barnes soil is suited to septic tank absorption fields, but the Sioux soil is poorly suited Both soils are suited to buildings. The moderately slow permeability of the Barnes soil is a limitation in septic tank absorption fields, but it can be overcome by enlarging the field. Because of the very rapid permeability, the Sioux soil readily absorbs but does not adequately filter the effluent. The poor filtering capacity may result in the pollution of ground water. A mound system helps to prevent this pollution. The shrink-swell potential of the Barnes soil is a limitation on building sites, but installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling. In areas of the Sioux soil, the sides of shallow excavations, such as those for basements, tend to cave in unless they are shored.

The land capability classification of the Barnes soil is IIIe, and that of the Sioux soil is VIs. The productivity index of both soils for spring wheat is 54.

44—Fordville loam, 0 to 3 percent slopes. This deep, level and nearly level, well drained soil is on glacial outwash plains. It is underlain by gravelly sand at a depth of about 29 inches. Individual areas range from about 5 to more than 150 acres in size.

Typically, the surface layer is black loam about 8 inches thick. The subsoil is about 25 inches thick. It is very dark brown loam in the upper part, very dark grayish brown loam in the next part, and dark brown gravelly sand in the lower part. The substratum to a depth of about 60 inches is dark brown gravelly sand. In some places the dark color of the surface layer extends to a depth of only 8 to 16 inches. In other places the depth to gravelly sand is 14 to 20 inches. In some areas the surface layer is sandy loam.

Included with this soil in mapping are small areas of Arveson, Arvilla, Divide, and Embden soils. These soils make up 5 to 10 percent of the unit. The poorly drained Arveson soils are in depressions. The somewhat poorly drained Divide soils are in swales. Arveson and Divide soils are highly calcareous. The somewhat excessively drained Arvilla soils are sandy loam in the surface layer and in the upper part of the subsoil. They are on knolls. Embden soils are in swales. They have a fine sand substratum.

Permeability is moderate in the upper part of the Fordville soil and rapid in the lower part. Runoff is slow. Available water capacity is moderate. Organic matter content is high. Tilth is good.

Most areas are used for cultivated crops. This soil is suited to wheat, oats, barley, flax, corn for silage, grasses, and legumes. The hazards of soil blowing and water erosion are slight. A system of conservation tillage that leaves crop residue on the surface helps to prevent excessive soil loss. It also helps to provide food and cover for resident and migratory wildlife.

The key range plants on this soil are little bluestem and green needlegrass. Intermediate and crested wheatgrass, smooth bromegrass, and alfalfa are suitable hay and pasture plants. No major hazards affect the use of this soil for range. Maintaining an adequate cover of the key plants helps protect the surface.

This soil is suited to some of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Because the soil is droughty, the trees and shrubs commonly are affected by moisture stress. Supplemental watering helps to ensure the survival of seedlings. Little benefit is derived from fallowing the season prior to planting because of the moderate available water capacity. Eliminating grasses and weeds before the trees and shrubs are planted and controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings.

This soil is poorly suited to septic tank absorption fields and is suited to buildings. Because of the rapid permeability, it readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity may result in the pollution of ground water. A mound system helps to prevent this pollution. The sides of shallow excavations, such as

those for basements, tend to cave in unless they are shored.

The land capability classification is IIs. The productivity index for spring wheat is 59.

49B—Arvilla sandy loam, 1 to 6 percent slopes. This deep, nearly level and undulating, somewhat excessively drained soil is on glacial outwash plains. It is underlain by coarse sand at a depth of about 22 inches. Individual areas range from about 10 to more than 1,500 acres in size.

Typically, the surface layer is very dark brown sandy loam about 8 inches thick. The subsoil is about 31 inches thick. It is very dark grayish brown sandy loam in the upper part, very dark grayish brown loamy sand in the next part, and dark grayish brown coarse sand in the lower part. The substratum to a depth of about 60 inches is grayish brown coarse sand. In some places the surface layer is loam or loamy sand. In other places the depth to sand or gravel is more than 25 inches.

Included with this soil in mapping are small areas of Arveson, Divide, Fordville, Maddock, and Sioux soils. These soils make up about 5 to 25 percent of the unit. The poorly drained Arveson soils are in depressions. The somewhat poorly drained Divide soils are in swales. Arveson and Divide soils are highly calcareous. The well drained Fordville soils are in swales. They are loam in the surface layer and in the upper part of the subsoil. Maddock soils have a loamy fine sand surface layer and subsoil. They occur as areas intermingled with areas of the Arvilla soil. Sioux soils have a very gravelly sand substratum. They are on knolls and ridges.

Permeability is moderately rapid in the upper part of the Arvilla soil and very rapid in the lower part. Runoff is slow. Available water capacity is low. Organic matter content is moderate. Tilth is good.

Most areas are used for cultivated crops. Some areas are irrigated. This soil is suited to wheat, oats, barley, flax, grasses, and legumes. The hazard of soil blowing is severe, and the hazard of water erosion is slight. A system of conservation tillage that leaves crop residue on the surface, windbreaks, and stripcropping help to control soil blowing (fig. 9). Conservation tillage also helps to provide food and cover for resident and migratory wildlife. In most years crops are affected by drought stress because of the low available water capacity. Leaving tall stubble on the surface helps to trap snow and thus increases the supply of soil moisture.

The key range plants on this soil are needleandthread and western wheatgrass. Intermediate and pubescent wheatgrass, smooth bromegrass, and alfalfa are suitable hay and pasture plants. Soil blowing, water erosion, and the low available water capacity are problems, especially if the range is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the key plants helps to control soil blowing and prevent denuding. Gullies can form along cattle trails. Cross fences that control the pattern of livestock traffic help to prevent gullying.

This soil is suited to some of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Because the soil is droughty, the trees and shrubs commonly are affected by moisture stress. Supplemental watering helps to ensure survival of the seedlings. Little benefit is derived from fallowing the season prior to planting because of the low available water capacity. Eliminating grasses and weeds before the trees and shrubs are planted and controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

This soil is poorly suited to septic tank absorption fields and is suited to buildings. Because of the very rapid permeability, it readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity may result in the pollution of ground water. A mound system helps to prevent this pollution. The sides of shallow excavations, such as those for basements, tend to cave in unless they are shored.

The land capability classification is IIIe. The productivity index for spring wheat is 42.

49C—Arvilla sandy loam, 6 to 9 percent slopes. This deep, gently rolling, somewhat excessively drained soil is on glacial outwash plains. It is underlain by gravelly sand at a depth of about 19 inches. Individual areas range from about 10 to more than 200 acres in size.

Typically, the surface layer is black sandy loam about 7 inches thick. The subsoil is about 12 inches thick. It is very dark grayish brown sandy loam in the upper part and brown loamy sand in the lower part. The substratum to a depth of about 60 inches is dark yellowish brown gravelly sand. In some places the substratum is fine sand. In other places the surface layer and subsoil are loam. In some areas the depth to gravelly sand is more than 25 inches.

Included with this soil in mapping are small areas of Divide, Embden, Maddock, and Sioux soils, which make up about 15 to 35 percent of the unit. The somewhat poorly drained Divide soils are in depressions. They are highly calcareous. The moderately well drained Embden soils are in swales. They are fine sandy loam in the upper part of the subsoil and are dark to a depth of 16 inches or more. Maddock soils have a loamy fine sand surface layer and subsoil and a fine sand substratum. They occur as areas intermingled with areas of the Arvilla soil. Sioux soils have a very gravelly sand substratum. They are on ridges and knolls.

Permeability is moderately rapid in the upper part of the Arvilla soil and very rapid in the lower part. Runoff is

Figure 9.—A field windbreak in an area of Arvilla sandy loam, 1 to 6 percent slopes.

slow. Available water capacity is low. Organic matter content is moderately low. Tilth is good.

Most areas are used as pasture or range. This soil is well suited to these uses. Some areas are used for cultivated crops. Because of a moderate hazard of water erosion, a severe hazard of soil blowing, and the low available water capacity, this soil is poorly suited to wheat, oats, barley, flax, grasses, and legumes. A system of conservation tillage that leaves crop residue on the surface, windbreaks, and stripcropping help to prevent excessive soil loss. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Seeding in the fall or early in spring helps to overcome the low available water capacity. Leaving tall stubble on the surface helps to trap snow and thus increases the supply of soil moisture.

The key range plants on this soil are needleandthread and western wheatgrass. Intermediate and pubescent wheatgrass, smooth bromegrass, and alfalfa are suitable hay and pasture plants. Soil blowing, water erosion, and the low available water capacity are problems, especially if the range is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the key plants helps to control soil blowing and water erosion and prevent denuding. Gullies can form along cattle trails. Cross fences that control the pattern of livestock traffic help to prevent gullying.

This soil is suited to some of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Because the soil is droughty, the trees and shrubs commonly are affected by moisture stress. Supplemental watering helps to ensure the survival of seedlings. Little benefit is derived from fallowing the season prior to planting because of the low available water capacity. Eliminating grasses and weeds before the trees and shrubs are planted and controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to

control soil blowing and protect the seedlings from abrasion.

This soil is poorly suited to septic tank absorption fields and is suited to buildings. Because of the very rapid permeability, it readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity may result in the pollution of ground water. A mound system helps to prevent this pollution. The sides of shallow excavations, such as those for basements, tend to cave in unless they are shored.

The land capability classification is IVe. The productivity index for spring wheat is 32.

49D—Arvilla sandy loam, 9 to 15 percent slopes. This deep, rolling, somewhat excessively drained soil is on glacial outwash plains. It is underlain by sand, fine sand, and gravelly sand at a depth of about 14 inches. Individual areas range from about 10 to more than 200 acres in size.

Typically, the surface layer is black sandy loam about 6 inches thick. The subsoil is very dark grayish brown sandy loam about 8 inches thick. The substratum to a depth of about 60 inches is dark grayish brown. It is sand in the upper part, fine sand in the next part, and stratified sand and gravelly sand in the lower part. In some places the depth to sand is less than 14 inches. In other places the surface layer is loamy sand. In some areas the lower part of the substratum is fine sand.

Included with this soil in mapping are small areas of Embden, Renshaw, and Serden soils, which make up about 5 to 25 percent of the unit. The moderately well drained Embden soils are in swales. They are fine sandy loam in the surface layer and the upper part of the subsoil and are dark to a depth of 16 inches or more. Renshaw soils are loam in the surface layer and the upper part of the subsoil. They occur as areas intermingled with areas of the Arvilla soil. The excessively drained Serden soils have a loamy fine sand surface layer and a fine sand substratum. They are on ridges and knolls.

Permeability is moderately rapid in the upper part of the Arvilla soil and very rapid in the lower part. Runoff is medium. Available water capacity is low. Organic matter content is moderately low.

Most areas are used as range. Because of a severe hazard of soil blowing, a moderate hazard of water erosion, and the low available water capacity, this soil is generally unsuited to wheat, oats, and barley. It is best suited to range. The key range plants are western wheatgrass and needleandthread. Intermediate and pubescent wheatgrass, smooth bromegrass, and alfalfa are suitable hay and pasture plants. Soil blowing, water erosion, and the low available water capacity are problems, especially if the range is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the key plants helps to control soil blowing and water erosion and prevent denuding. Gullies can form along cattle trails. Cross fences that control the pattern of livestock traffic help to prevent gullying.

This soil is suited to some of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Because the soil is droughty, the trees and shrubs commonly are affected by moisture stress. Supplemental watering helps to ensure the survival of seedlings. Little benefit is derived from fallowing the season prior to planting because of the low available water capacity. Eliminating grasses and weeds before the trees and shrubs are planted and controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

This soil is poorly suited to septic tank absorption fields and is suited to buildings. Because of the very rapid permeability, it readily absorbs but does not adequately filter effluent in septic tank absorption fields. The poor filtering capacity may result in the pollution of ground water. A mound system helps to prevent this pollution. The slope is a limitation on sites for buildings and septic tank absorption fields, but it can be overcome by designing the buildings and absorption fields so that they conform to the natural slope of the land. The sides of shallow excavations, such as those for basements, tend to cave in unless they are shored.

The land capability classification is VIe. The productivity index for spring wheat is 0.

52—Hamerly loam, 0 to 3 percent slopes. This deep, level and nearly level, somewhat poorly drained, highly calcareous soil is on the lower foot slopes on glacial till plains. Individual areas range from about 10 to more than 100 acres in size.

Typically, the surface layer is black loam about 7 inches thick. The subsoil is mottled clay loam about 29 inches thick. It is light brownish gray in the upper part and olive in the lower part. The substratum to a depth of about 60 inches is olive, mottled clay loam.

Included with this soil in mapping are small areas of Divide, Svea, and Tonka soils, which make up 5 to 15 percent of the unit. Divide soils have a gravelly coarse sand substratum. They occur as areas intermingled with areas of the Hamerly soil. The moderately well drained Svea soils are higher on the landscape than the Hamerly soil. They are highly calcareous. The poorly drained Tonka soils are in depressions. They have a silty clay loam subsoil.

Permeability is moderately slow in the Hamerly soil, and runoff is slow. Available water capacity is high. A seasonal high water table is at a depth of 2 to 4 feet. Organic matter content is high. Tilth is good.

Most areas are used for cultivated crops. This soil is suited to wheat, oats, barley, flax, corn for silage, grasses, and legumes. The hazard of soil blowing is moderate, and the hazard of water erosion is slight. A system of conservation tillage that leaves crop residue on the surface and windbreaks help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Wetness delays tillage and seeding in some years, but it does not prevent planting of the commonly grown crops.

The key range plants on this soil are western wheatgrass and needleandthread. Crested wheatgrass, pubescent wheatgrass, intermediate wheatgrass, smooth bromegrass, and alfalfa are suitable hay and pasture plants. No major hazards affect the use of this soil for range. Maintaining an adequate cover of the key plants helps to protect the surface.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. No critical limitations affect the trees and shrubs. Eliminating grasses and weeds before the trees and shrubs are planted and controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

This soil is poorly suited to septic tank absorption fields and buildings because of the seasonal high water table and the moderately slow permeability. In this survey area, Hamerly soils generally are not used as building sites or absorption fields. Better sites generally are nearby.

The land capability classification is IIe. The productivity index for spring wheat is 82.

55B—Hecla-Ulen loamy fine sands, 1 to 6 percent slopes. These deep soils are on glacial outwash plains. The moderately well drained, nearly level and undulating Hecla soil is on flats. The somewhat poorly drained, nearly level, highly calcareous Ulen soil is in slight depressions. Individual areas range from about 10 to more than 150 acres in size. They are about 35 to 75 percent Hecla soil and 5 to 55 percent Ulen soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the surface soil of the Hecla soil is about 29 inches thick. It is black loamy fine sand in the upper part and very dark grayish brown loamy sand in the lower part. The next layer is very dark grayish brown, mottled loamy sand. The substratum to a depth of about 60 inches is brown, mottled loamy sand. In some places the surface soil is loamy sand, sand, or sandy loam.

Typically, the surface soil of the Ulen soil is loamy fine sand about 12 inches thick. It is black in the upper part and very dark gray in the lower part. The subsoil is about 26 inches thick. It is dark gray loamy fine sand in the upper part and olive fine sand in the lower part. The substratum to a depth of about 60 inches is olive, mottled fine sand. In some places the surface layer is fine sand, loamy coarse sand, or sandy loam.

Included with these soils in mapping are small areas of Arveson, Arvilla, Embden, Maddock, and Minnewaukan soils. These included soils make up about 5 to 15 percent of the unit. The very poorly drained, highly calcareous Arveson soil is in depressions. They have a loam surface layer. The somewhat excessively drained Arvilla soils are on rises. They have a coarse sand substratum. Embden soils are fine sandy loam to a depth of about 30 inches. They occur as areas intermingled with areas of the Hecla soil. The well drained Maddock soils are on low ridges. The poorly drained Minnewaukan soils are on small flats. They have a sandy loam surface layer about 3 inches thick.

Permeability is rapid in the Hecla and Ulen soils, and runoff is slow. Available water capacity is low in the Hecla soil and moderate in the Ulen soil. A seasonal high water table is at a depth of 2.5 to 6.0 feet in the Ulen soil and 3.0 to 6.0 feet in the Hecla soil. Organic matter content is moderate in both soils. Tilth is good.

Most areas are used for cultivated crops. These soils are suited to wheat, oats, barley, flax, corn for silage, grasses, and legumes. The hazard of soil blowing is severe, and the hazard of water erosion is slight. In most years crops are affected by moisture stress because of the limited available water capacity. A system of conservation tillage that leaves crop residue on the surface, windbreaks, and stripcropping help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Leaving tall stubble on the surface helps to trap snow and thus increases the supply of soil moisture.

The key range plants on these soils are sand bluestem, little bluestem, big bluestem, and prairie sandreed. Crested wheatgrass, intermediate wheatgrass, pubescent wheatgrass, smooth bromegrass, and alfalfa are suitable hay and pasture plants. Soil blowing and the limited available water capacity are problems, especially if the range is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the key plants helps to control soil blowing and prevent denuding.

These soils are suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. They have no critical limitations. Eliminating grasses and weeds before the trees and shrubs are planted and controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

Because of the seasonal high water table and a poor filtering capacity, these soils are poorly suited to septic tank absorption fields. Because of the rapid permeability,

they readily absorb but do not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity may result in the pollution of ground water. A mound system helps to prevent this pollution and increases the depth to the seasonal high water table. The sides of shallow excavations, such as those for basements, tend to cave in unless they are shored. The soils are suited to buildings, but the wetness is a limitation on sites for buildings with basements. Installing a system of surface and foundation drains helps to prevent seepage into basements.

The land capability classification is IVe. The productivity index for spring wheat is 46.

56B—Maddock loamy fine sand, 1 to 6 percent slopes. This deep, nearly level and undulating, well drained soil is on glacial outwash plains. Individual areas range from about 10 to more than 1,000 acres in size.

Typically, the surface soil is loamy fine sand about 16 inches thick. It is black in the upper part and very dark brown in the lower part. The subsoil is dark brown loamy fine sand about 3 inches thick. The substratum to a depth of about 60 inches is fine sand. It is brown in the upper part and dark grayish brown in the lower part. In some places the dark color of the surface soil extends to a depth of more than 20 inches. In other places the substratum is mottled. In some areas the soil has layers of coarse sand or sand.

Included with this soil in mapping are small areas of Arveson, Arvilla, Embden, and Towner soils. These soils make up about 5 to 30 percent of the unit. The poorly drained Arveson soils are in depressions. They are highly calcareous. Arvilla soils have a coarse sand substratum. They occur as areas intermingled with areas of the Maddock soil. The moderately well drained Embden soils are fine sandy loam to a depth of about 30 inches. They are in swales. Towner soils have a loam substratum at a depth of about 40 inches. They occur as areas intermingled with areas of the Maddock soil.

Permeability is rapid and runoff is slow. Available water capacity and organic matter content are low. Tilth is good.

Most areas are used for cultivated crops. Some areas are irrigated. This soil is suited to wheat, oats, barley, flax, grasses, and legumes. The hazard of soil blowing is severe, and the hazard of water erosion is slight. A system of conservation tillage that leaves crop residue on the surface, windbreaks, and stripcropping help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. In most years crops are affected by drought stress because of the low available water capacity. Leaving tall stubble on the surface helps to trap snow and thus increases the supply of soil moisture.

The key range plants on this soil are prairie sandreed and needleandthread. Intermediate wheatgrass, crested wheatgrass, pubescent wheatgrass, smooth bromegrass, and alfalfa are suitable hay and pasture plants. Soil blowing and the low available water capacity are problems, especially if the range is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the key plants helps to control soil blowing and prevent denuding.

This soil is suited to many of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Because the soil is somewhat droughty, the trees and shrubs commonly are affected by moisture stress. Supplemental watering helps to ensure the survival of seedlings. Little benefit is derived from fallowing the season prior to planting because of the low available water capacity. Eliminating grasses and weeds before the trees and shrubs are planted and controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

This soil is poorly suited to septic tank absorption fields and is suited to buildings. Because of the rapid permeability, it readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity may result in the pollution of ground water. A mound system helps to prevent this pollution. The sides of shallow excavations, such as those for basements, tend to cave in unless they are shored.

The land capability classification is IVe. The productivity index for spring wheat is 42.

61—Nutley silty clay, 1 to 3 percent slopes. This deep, nearly level, well drained soil is on glacial lake plains. Individual areas range from about 5 to more than 200 acres in size.

Typically, the surface layer is black silty clay about 8 inches thick. The subsoil is dark grayish brown silty clay about 36 inches thick. It is mottled between depths of 19 and 44 inches. The substratum to a depth of about 60 inches is dark grayish brown, mottled silty clay. In some places the dark color of the surface layer extends to a depth of 16 to 20 inches. In other places the surface layer is silty clay loam or clay. In some areas the soil has a silt loam subsurface layer and a subsoil of dense silty clay.

Included with this soil in mapping are small areas of Barnes, Overly, and Tonka soils. These soils make up about 5 to 10 percent of the unit. Barnes soils have a loam surface layer and subsoil. They higher on the landscape than the Nutley soil. Overly soils have a silt loam surface layer and are silty clay loam in the lower part of the substratum. They occur as areas intermingled with areas of the Nutley soil. The poorly drained Tonka soils are in depressions.

Permeability is slow in the Nutley soil. Runoff also is slow. Available water capacity is moderate. Organic matter content is high. Tilth is poor.

Most areas are used for cultivated crops. This soil is suited to wheat, oats, barley, flax, corn for silage, grasses, and legumes. The hazard of soil blowing is moderate, and the hazard of water erosion is slight. A system of conservation tillage that leaves crop residue on the surface and windbreaks help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

The key range plants on this soil are green needlegrass and western wheatgrass. Intermediate wheatgrass, smooth bromegrass, and alfalfa are suitable hay and pasture plants. No major hazards affect the use of this soil for range. Maintaining an adequate cover of the key plants helps to protect the surface.

This soil is suited to many of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

This soil is poorly suited to septic tank absorption fields and is suited to buildings. The slow permeability is a severe limitation in septic tank absorption fields, but it can be overcome by a mound system. The shrink-swell potential is a limitation on building sites, but installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling.

The land capability classification is IIs. The productivity index for spring wheat is 84.

61B—Nutley silty clay, 3 to 6 percent slopes. This deep, undulating, well drained soil is on glacial lake plains. Individual areas range from about 5 to more than 100 acres in size.

Typically, the surface layer is very dark gray silty clay about 8 inches thick. The subsoil is dark grayish brown silty clay about 33 inches thick. The substratum to a depth of about 60 inches is olive, mottled silty clay. In places the dark color of the surface layer extends to a depth of 16 to 20 inches. In other places the surface layer is silty clay loam or clay. In some areas the soil has a silt loam subsurface layer and a subsoil of dense silty clay.

Included with this soil in mapping are small areas of Barnes, Overly, and Tonka soils. These soils make up about 10 to 25 percent of the unit. Barnes soils have a loam surface layer and subsoil. They are higher on the landscape than the Nutley soil. Overly soils have a silt loam surface layer and are silty clay loam in the lower part of the substratum. They occur as areas intermingled with areas of the Nutley soil. The poorly drained Tonka soils are in depressions.

Permeability is slow in the Nutley soil, and runoff is medium. Available water capacity is moderate. Organic matter content is high. Tilth is poor.

Most areas are used for cultivated crops. This soil is suited to wheat, oats, barley, flax, corn for silage, grasses, and legumes. The hazards of soil blowing and water erosion are moderate. A system of conservation tillage that leaves crop residue on the surface, windbreaks, and stripcropping help to prevent excessive soil loss. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

The key range plants on this soil are green needlegrass and western wheatgrass. Intermediate wheatgrass, smooth bromegrass, and alfalfa are suitable hay and pasture plants. No major hazards affect the use of this soil for range. Maintaining an adequate cover of the key plants helps to protect the surface.

This soil is suited to many of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

This soil is poorly suited to septic tank absorption fields and is suited to buildings. The slow permeability is a severe limitation in septic tank absorption fields, but it can be overcome by a mound system. The shrink-swell potential is a limitation on building sites, but installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling.

The land capability classification is IIe. The productivity index for spring wheat is 74.

63C—Sioux-Arvilla sandy loams, 1 to 9 percent slopes. These deep, nearly level to gently rolling soils are on glacial outwash plains. The excessively drained Sioux soil is underlain by gravelly sand at a depth of about 8 inches. It is on knobs and knolls. The somewhat excessively drained Arvilla soil is underlain by gravelly coarse sand and coarse sand at a depth of about 16 inches. It is on side slopes and flats. Individual areas range from about 10 to more than 1,000 acres in size. They are about 55 to 75 percent Sioux soil and 20 to 40 percent Arvilla soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Sioux soil has a black sandy loam surface layer about 8 inches thick. The substratum to a depth of about 60 inches is very gravelly sand (fig. 10). It is brown and mottled in the upper part and dark yellowish brown in the lower part. In some places the

Figure 10.—Profile of the Sioux soil in an area of Sioux-Arvilla sandy loams, 1 to 9 percent slopes. The content of gravel in the substratum is 35 to 60 percent.

surface layer is loam or sandy loam. In other places it is only 4 to 7 inches thick. In some areas the substratum is sand or coarse sand.

Typically, the Arvilla soil has a black sandy loam surface layer about 8 inches thick. The subsoil is very dark grayish brown sandy loam about 8 inches thick. The upper part of the substratum is yellowish brown gravelly coarse sand. The lower part to a depth of about 60 inches is dark grayish brown coarse sand. In places the surface layer and subsoil are loam.

Included with these soils in mapping are small areas of Barnes, Divide, Fordville, and Marysland soils. These included soils make up about 5 to 10 percent of the unit. The well drained Barnes soils have a loam surface layer and a clay loam substratum. They occur as areas intermingled with areas of the Sioux and Arvilla soils. The somewhat poorly drained Divide and poorly drained Marysland soils are in depressions. They are highly calcareous. The well drained Fordville soils are on flats. They are loam in the upper part of the subsoil.

Permeability is very rapid for the Sioux soil. It is moderately rapid in the upper part of the Arvilla soil and very rapid in the lower part. Runoff is slow on both soils. Available water capacity is low. Organic matter content is moderately low in the Sioux soil and moderate in the Arvilla soil.

Most areas are used for hay or range (fig. 11). Because of a severe hazard of soil blowing and the droughtiness, these soils generally are unsuited to wheat, oats, and barley. They are best suited to hay and range. The key range plants are blue grama and needleandthread. Crested wheatgrass, intermediate wheatgrass, pubescent wheatgrass, alfalfa, and smooth bromegrass are suitable hay and pasture plants. Soil blowing, water erosion, and the low available water capacity are problems, especially if the range is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the key plants helps to control soil blowing and water erosion and prevent denuding. Gullies can form along cattle trails. Cross fences that control the pattern of livestock traffic help to prevent gullying.

The Sioux soil generally is unsuited to the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Arvilla soil is suited to some of the climatically adapted species, but it is droughty. The trees and shrubs commonly are affected by moisture stress. Little benefit is derived from fallowing the season prior to planting because of the low available water capacity. Eliminating grasses and weeds before the trees and shrubs are planted and controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

These soils are poorly suited to septic tank absorption fields and are suited to buildings. Because of the very rapid permeability, they readily absorb but do not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity may result in pollution of ground water. A mound system helps to prevent this pollution. The sides of shallow excavations, such as those for basements, tend to cave in unless they are shored.

The land capability classification of the Sioux soil is VIs, and that of the Arvilla soil is IVe. The productivity index of both soils for spring wheat is 0.

63E—Sioux-Arvilla sandy loams, 9 to 35 percent slopes. These deep soils are on glacial outwash plains. Most areas are dissected by glacial streams. The

Figure 11.—An area of Sioux-Arvilla sandy loams, 1 to 9 percent slopes, used for hay.

excessively drained, rolling to steep Sioux soil is on ridges, knobs, and knolls. It is underlain by gravelly and sandy material at a depth of about 11 inches. Some of the ridges are stony or bouldery. The somewhat excessively drained, rolling Arvilla soil is on the sides of ridges. It is underlain by gravelly sand at a depth of about 16 inches. Individual areas range from about 10 to more than 1,000 acres in size. They are about 65 to 80 percent Sioux soil and 10 to 25 percent Arvilla soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Sioux soil has a black sandy loam surface layer about 7 inches thick. The next layer is very dark grayish brown sandy loam about 4 inches thick. The upper part of the substratum is brown very gravelly loamy coarse sand. The next part is light gray sand. The lower part to a depth of about 60 inches is brown gravelly sand. In some places the surface layer is only 2 to 6 inches thick. In other places it is loam, loamy sand, gravelly loam, or sandy loam.

Typically, the Arvilla soil has a black sandy loam surface layer about 8 inches thick. The subsoil is very dark gray sandy loam about 8 inches thick. The substratum to a depth of about 60 inches is dark grayish brown gravelly sand. In places the surface layer is loam or gravelly loam.

Included with these soils in mapping are small areas of Barnes, Divide, Fordville, and Tonka soils. These

included soils make up 5 to 15 percent of the unit. The well drained Barnes soils have a loam surface layer and a clay loam substratum. They occur as areas intermingled with areas of the Sioux and Arvilla soils. The somewhat poorly drained Divide soils are in depressions. They are highly calcareous. The well drained Fordville soils are on flats. They are loam in the upper part of the subsoil.

Permeability is very rapid in the Sioux soil. It is moderately rapid in the upper part of the Arvilla soil and very rapid in the lower part. Runoff is slow on both soils. Available water capacity is low. Organic matter content is moderately low.

Most areas are used as range. Because of severe hazards of soil blowing and water erosion and the droughtiness, these soils generally are unsuited to wheat, oats, and barley. They are best suited to range. The key range plants are blue grama and needleandthread. Soil blowing, water erosion, and the low available water capacity are problems, especially if the range is overgrazed. Reestablishing vegetation is difficult in denuded areas. The slope limits the use of machinery. Maintaining an adequate cover of the key plants helps to control soil blowing and water erosion and prevent denuding. Gullies can form along cattle trails. Cross fences that control the pattern of livestock traffic help to prevent gullying.

The Sioux soil generally is unsuited to the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Arvilla soil is suited to some species, but it is droughty. The trees and shrubs commonly are affected by moisture stress. The slope limits the use of machinery. Little benefit is derived from fallowing the season prior to planting because of the low available water capacity. Eliminating grasses and weeds before the trees and shrubs are planted and controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

These soils are poorly suited to septic tank absorption fields and are suited to buildings. Because of the very rapid permeability, they readily absorb but do not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity may result in the pollution of ground water. A mound system helps to prevent this pollution. The slope is a limitation on sites for buildings and septic tank absorption fields, but it can be overcome by designing buildings and absorption fields so that they conform to the natural slope of the land. The sides of shallow excavations, such as those for basements, tend to cave in unless they are shored.

The land capability classification of the Sioux soil is VIIs, and that of the Arvilla soil is VIe. The productivity index of both soils for spring wheat is 0.

64B—Renshaw-Sioux loams, 1 to 6 percent slopes. These deep, nearly level and undulating soils are on glacial outwash plains. The somewhat excessively drained Renshaw soil is underlain by gravelly loamy sand at a depth of about 17 inches. It is on side slopes and flats. The excessively drained Sioux soil is underlain by gravelly sand at a depth of about 12 inches. It is on knobs and knolls. Individual areas range from about 10 to more than 2,500 acres in size. They are about 40 to 55 percent Renshaw soil and 35 to 50 percent Sioux soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Renshaw soil has a black loam surface layer about 8 inches thick. The subsoil is dark grayish brown loam about 9 inches thick. The upper part of the substratum is very dark grayish brown gravelly loamy sand. The lower part to a depth of about 60 inches is dark yellowish brown very gravelly sand. In some places, the dark color of the surface layer extends to a depth of 16 to 30 inches and the depth to gravelly loamy sand is more than 22 inches. In other places the surface layer is sandy loam.

Typically, the Sioux soil has a black loam surface layer about 7 inches thick. The next layer is dark grayish brown sandy loam about 5 inches thick. The substratum to a depth of about 60 inches is dark brown very gravelly sand. In some places the surface layer is sandy loam, loamy sand, gravelly sandy loam, or gravelly loamy sand. In other places it is only 4 to 6 inches thick.

Included with these soils in mapping are small areas of Arvilla, Colvin, Divide, and Embden soils. These included soils make up about 5 to 25 percent of the unit. Arvilla soils are sandy loam in the surface layer and in the upper part of the subsoil. They occur as areas intermingled with areas of the Renshaw soil. The very poorly drained Colvin soils are in depressions. They have a silt loam surface layer and a clay loam substratum. The somewhat poorly drained Divide soils are in shallow depressions. They are highly calcareous. The moderately well drained Embden soils are in swales. They are fine sandy loam to a depth of about 30 inches.

Permeability is moderately rapid in the upper part of the Renshaw soil and very rapid in the lower part. It is very rapid in the Sioux soil. Runoff is slow on both soils. Available water capacity is low. Organic matter content is moderate in the Renshaw soil and moderately low in the Sioux soil. Tilth is good in both soils.

Most areas are used for cultivated crops. Some areas are irrigated. These soils are suited to wheat, oats, barley, flax, corn for silage, grasses, and legumes. The hazard of soil blowing is slight, and the hazard of water erosion is moderate. A system of conservation tillage that leaves crop residue on the surface helps to control erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. In most years crops are affected by moisture stress because of the low available water capacity. Seeding in the fall or

early in the spring helps to overcome this limitation. Leaving tall stubble on the surface helps to trap snow and thus increases the supply of soil moisture.

The key range plants on these soils are needleandthread, little bluestem, and blue grama. Crested wheatgrass, intermediate wheatgrass, pubescent wheatgrass, smooth bromegrass, and alfalfa are suitable hay and pasture plants. Water erosion and the low available water capacity are problems, especially if the range is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the key plants helps to control water erosion and prevent denuding. Gullies can form along cattle trails. Cross fences that control the pattern of livestock traffic help to prevent gullying.

The Renshaw soil is suited to some of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings, but the Sioux soil generally is unsuited to all species. Because the Renshaw soil is droughty, the trees and shrubs commonly are affected by moisture stress. Supplemental watering helps to ensure the survival of seedlings. Little benefit is derived from fallowing the season prior to planting because of the low available water capacity. Eliminating grasses and weeds before the trees and shrubs are planted and controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings.

These soils are poorly suited to septic tank absorption fields and are suited to buildings. Because of the very rapid permeability, they readily absorb but do not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity may result in the pollution of ground water. A mound system helps to prevent this pollution. The sides of shallow excavations, such as those for basements, tend to cave in unless they are shored.

The land capability classification of the Renshaw soil is IIIe, and that of the Sioux soil is VIs. The productivity index of both soils for spring wheat is 34.

65—Renshaw loam, 0 to 3 percent slopes. This deep, level and nearly level, somewhat excessively drained soil is on glacial outwash plains. It is underlain by gravelly sand at a depth of about 19 inches. Individual areas range from about 10 to more than 400 acres in size.

Typically, the surface layer is black loam about 7 inches thick. The subsoil is about 12 inches thick. It is very dark brown loam in the upper part and dark brown gravelly coarse sand in the lower part. The substratum to a depth of about 60 inches is dark brown gravelly sand. In some places, the dark color of the surface layer extends to a depth of 16 to 30 inches and the depth to gravelly coarse sand is more than 22 inches. In other places the subsoil is sandy loam.

Included with this soil in mapping are small areas of Arvilla, Divide, Marysland, and Sioux soils. These soils make up about 5 to 25 percent of the unit. Arvilla soils are sandy loam in the surface layer and in the upper part of the subsoil. They occur as areas intermingled with areas of the Renshaw soil. The somewhat poorly drained Divide soils are in swales. The poorly drained Marysland soils are in depressions. They are highly calcareous. Sioux soils are on slight rises. They have a very gravelly sand substratum. Also included are some undulating areas.

Permeability is moderately rapid in the upper part of the Renshaw soil and very rapid in the lower part. Runoff is slow. Available water capacity is low. Organic matter content is moderate. Tilth is good.

Most areas are used for cultivated crops. Some areas are irrigated. This soil is suited to wheat, oats, barley, flax, corn for silage, grasses, and legumes. The hazards of soil blowing and water erosion are slight. A system of conservation tillage that leaves crop residue on the surface helps to protect the surface. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. In most years crops are affected by moisture stress because of the low available water capacity. Seeding in the fall or early in spring helps to overcome this limitation. Leaving tall stubble on the surface helps to trap snow and thus increases the supply of soil moisture.

The key range plants on this soil are needleandthread, little bluestem, and sideoats grama. Crested and intermediate wheatgrass, smooth bromegrass, and alfalfa are suitable hay and pasture plants. The low available water capacity is a limitation, especially if the range is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the key plants helps to protect the surface.

This soil is suited to some of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Because the soil is droughty, the trees and shrubs commonly are affected by moisture stress. Supplemental watering helps to ensure the survival of seedlings. Little benefit is derived from fallowing the season prior to planting because of the low available water capacity. Eliminating grasses and weeds before the trees and shrubs are planted and controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings.

This soil is poorly suited to septic tank absorption fields and is suited to buildings. Because of the very rapid permeability, it readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity may result in the pollution of ground water. A mound system helps to prevent this pollution. The sides of shallow excavations, such as those for basements, tend to cave in unless they are shored.

The land capability classification is IIIs. The productivity index for spring wheat is 47.

66C—Williams-Zahl loams, 6 to 9 percent slopes. These deep, gently rolling, well drained soils are on glacial till plains. The Williams soil is on side slopes. The Zahl soil is on knolls, ridges, and shoulder slopes. Individual areas range from about 10 to more than 100 acres in size. They are about 50 to 80 percent Williams soil and 10 to 30 percent Zahl soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Williams soil has a very dark brown loam surface layer about 5 inches thick. The subsoil is clay loam about 15 inches thick. It is dark brown in the upper part and dark grayish brown in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled clay loam. In some places the dark color of the surface layer extends to a depth of more than 16 inches. In other places the surface layer is sandy loam. In some areas the subsoil does not have a layer of accumulated clay.

Typically, the Zahl soil has a very dark brown loam surface layer about 6 inches thick. The subsoil is dark grayish brown, mottled clay loam about 20 inches thick. The substratum to a depth of about 60 inches is dark grayish brown, mottled clay loam. In some places the surface layer is sandy loam. In other places it is lighter colored and is only 2 to 5 inches thick.

Included with these soils in mapping are small areas of Flaxton, Noonan, Parnell, Sioux, and Tonka soils. These included soils make up about 5 to 15 percent of the unit. The Flaxton soils have a fine sandy loam surface layer. They occur as areas intermingled with areas of the Williams soil. The moderately well drained Noonan soils are in swales. They have a dense, alkali subsoil. The very poorly drained Parnell and poorly drained Tonka soils are in depressions. The excessively drained Sioux soils are on knolls. They have a very gravelly sand substratum. Also included are some cobbly or stony areas.

Permeability is moderately slow in the Williams and Zahl soils, and runoff is medium. Available water capacity is high. Organic matter content is moderate. Tilth is good.

Most areas are used for cultivated crops. These soils are suited to wheat, oats, barley, flax, grasses, and legumes. The hazard of water erosion is severe on both soils, and the hazard of soil blowing is moderate on the Zahl soil. A system of conservation tillage that leaves crop residue on the surface, windbreaks, and stripcropping help to control soil blowing and water erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

The key range plants on these soils are needleandthread, western wheatgrass, and little bluestem. Crested wheatgrass, intermediate wheatgrass, pubescent wheatgrass, smooth bromegrass, and alfalfa are suitable hay and pasture plants. Soil blowing and water erosion are hazards, especially if the range is overgrazed. They can be controlled by maintaining an adequate cover of the key plants. Gullies can form along cattle trails. Cross fences that control the pattern of livestock traffic help to prevent gullying.

The Williams soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Zahl soil is suited only to the most drought tolerant species. Optimum growth, survival, and vigor are unlikely on this soil. Eliminating grasses and weeds before the trees and shrubs are planted and controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. On the Zahl soil, strips of an annual cover crop between the rows help to control soil blowing and protect the seedlings from abrasion.

These soils are suited to septic tank absorption fields and buildings. The moderately slow permeability is a limitation in septic tank absorption fields, but it can be overcome by enlarging the field. The shrink-swell potential is a limitation on building sites, but installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling.

The land capability classification of the Williams soil is IIIe; and that of the Zahl soil is IVe. The productivity index of both soils for spring wheat is 49.

66E—Williams-Zahl loams, 9 to 35 percent slopes. These deep, well drained soils are on glacial till plains and moraines. The rolling and hilly Williams soil is on side slopes and on the summits of ridges. The rolling to steep Zahl soil is on narrow ridges and shoulder slopes. Individual areas range from about 15 to more than 1,500 acres in size. They are about 45 to 60 percent Williams soil and 35 to 45 percent Zahl soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Williams soil has a very dark brown loam surface layer about 5 inches thick. The subsoil is clay loam about 15 inches thick. It is dark brown in the upper part and dark grayish brown in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled clay loam. In some places the dark color of the surface layer extends to a depth of more than 16 inches. In other places the surface layer is sandy loam. In some areas the subsoil does not have a layer of accumulated clay.

Typically, the Zahl soil has a very dark brown loam surface layer about 6 inches thick. The subsoil is dark grayish brown, mottled clay loam about 20 inches thick. The substratum to a depth of about 60 inches is dark grayish brown, mottled clay loam. In some places the surface layer is lighter colored and is only 2 to 5 inches thick. In other places it is sandy loam or gravelly loam.

Included with these soils in mapping are small areas of Noonan, Parnell, Sioux, and Vebar soils. These included soils make up about 5 to 10 percent of the unit. The

moderately well drained Noonan soils are in swales. They have a dense, alkali subsoil. The very poorly drained Parnell soils are in depressions. The excessively drained Sioux soils are on ridges. They have a very gravelly sand substratum. Vebar soils are moderately deep to soft sandstone. They are on ridges. Also included are some cobbly or stony areas.

Permeability is moderately slow in the Williams and Zahl soils, and runoff is rapid. Available water capacity is high. Organic matter content is moderate. Tilth is good.

Most areas are used as range. Because of a severe hazard of water erosion on both soils, a moderate hazard of soil blowing on the Zahl soil, and the slope of both soils, this unit is generally unsuited to wheat, oats, and barley. It is best suited to range. The key range plants are western wheatgrass, little bluestem, and needleandthread. Soil blowing and water erosion are hazards, especially if the range is overgrazed. Reestablishing vegetation is difficult in denuded areas. The slope limits the use of machinery. Maintaining an adequate cover of the key plants helps to control soil blowing and water erosion and prevent denuding.

The Zahl soil and the hilly areas of the Williams soil generally are unsuited to the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Trees and shrubs can be grown to enhance esthetic effects or improve wildlife habitat if they are hand planted or scalp planted. The rolling areas of the Williams soil are suited to nearly all of the climatically adapted species. Eliminating grasses and weeds before the trees and shrubs are planted and controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings.

These soils are poorly suited to septic tank absorption fields and buildings. The moderately slow permeability is a limitation in septic tank absorption fields, but it can be overcome by enlarging the field. The shrink-swell potential is a limitation building sites, but installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling. The slope is a limitation on sites for buildings and septic tank absorption fields, but it can be overcome by designing the buildings and absorption fields so that they conform to the natural slope of the land.

The land capability classification of the Williams soil is VIe, and that of the Zahl soil is VIIe. The productivity index of both soils for spring wheat is 0.

67—Williams-Bowbells loams, 1 to 3 percent slopes. These deep, nearly level soils are on glacial till plains. The well drained Williams soil is on flats. The moderately well drained Bowbells soil is in swales. Individual areas range from about 10 to more than 2,500 acres in size. They are about 40 to 60 percent Williams soil and 25 to 45 percent Bowbells soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Williams soil has a very dark brown loam surface layer about 7 inches thick. The subsoil is clay loam about 20 inches thick. It is dark grayish brown in the upper part and light olive brown in the lower part. The substratum to a depth of about 60 inches is grayish brown clay loam. In some places the subsoil does not have a layer of accumulated clay. In other places the substratum is silty clay loam.

Typically, the Bowbells soil has a black loam surface soil about 13 inches thick. The subsoil is about 36 inches thick. It is very dark grayish brown clay loam in the upper part, very dark grayish brown loam in the next part, and grayish brown clay loam in the lower part. The substratum to a depth of about 60 inches is dark grayish brown clay loam. In some places the surface layer is silt loam. In other places a thin layer of gravelly loam or gravelly sandy loam is between the subsoil and the substratum.

Included with these soils in mapping are small areas of Fordville, Hamerly, Noonan, Parnell, and Tonka soils. These included soils make up about 5 to 15 percent of the unit. Fordville soils have a gravelly sand substratum. They are in swales. The somewhat poorly drained Hamerly soils are on the rims of depressions. They are highly calcareous. Noonan soils are in swales. They have a dense, alkali subsoil. The very poorly drained Parnell and poorly drained Tonka soils are in depressions.

Permeability is moderately slow in the Williams and Bowbells soils, and runoff is slow. Available water capacity and organic matter content are high. Tilth is good.

Most areas are used for cultivated crops. These soils are suited to wheat, oats, barley, flax, grasses, and legumes. The hazards of soil blowing and water erosion are slight. A system of conservation tillage that leaves crop residue on the surface helps to protect the surface. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

The key range plants on these soils are western wheatgrass, green needlegrass, and big bluestem. Crested and intermediate wheatgrass, smooth bromegrass, switchgrass, and alfalfa are suitable hay and pasture plants. No major hazards affect the use of these soils for range. Maintaining an adequate cover of the key plants helps to protect the surface.

The Williams soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Bowbells soil is suited to all climatically adapted species. It has no critical limitations. Eliminating grasses and weeds before the trees and shrubs are planted and controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings.

These soils are suited to septic tank absorption fields and buildings. The moderately slow permeability is a limitation in septic tank absorption fields, but it can be overcome by enlarging the field. The shrink-swell potential is a limitation on building sites, but installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling.

The land capability classification is IIc. The productivity index for spring wheat is 83.

67B—Williams-Bowbells loams, 3 to 6 percent slopes. These deep, undulating soils are on glacial till plains. The well drained Williams soil is on flats and side slopes. The moderately well drained Bowbells soil is in swales. Individual areas range from about 10 to more than 1,500 acres in size. They are about 40 to 75 percent Williams soil and 10 to 50 percent Bowbells soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Williams soil has a very dark brown loam surface layer about 7 inches thick. The subsoil is clay loam about 16 inches thick. It is dark brown in the upper part and grayish brown in the lower part. The substratum to a depth of about 60 inches is olive brown loam. In some places the surface layer is fine sandy loam, silt loam, or clay loam. In other places the subsoil does not have a layer of accumulated clay.

Typically, the Bowbells soil has a black loam surface soil about 13 inches thick. The subsoil is about 36 inches thick. It is very dark grayish brown clay loam in the upper part, very dark grayish brown loam in the next part, and grayish brown clay loam in the lower part. The substratum to a depth of about 60 inches is dark grayish brown clay loam. In some places the surface layer is silt loam. In other places a thin layer of gravelly loam or gravelly sandy loam is between the subsoil and the substratum.

Included with these soils in mapping are small areas of Hamerly, Noonan, Parnell, Tonka, and Zahl soils. These included soils make up about 5 to 25 percent of the unit. The somewhat poorly drained Hamerly soils are on the rims of depressions. They are highly calcareous. Noonan soils are in swales. They have a dense, alkali subsoil. The very poorly drained Parnell and poorly drained Tonka soils are in depressions. The well drained Zahl soils are on low knobs and knolls. They have a calcareous subsoil.

Permeability is moderately slow in the Williams and Bowbells soils, and runoff is medium. Available water capacity and organic matter content are high. Tilth is good.

Most areas are used for cultivated crops. These soils are suited to wheat, oats, barley, flax, grasses, and legumes. The hazard of soil blowing is slight, and the hazard of water erosion is moderate. A system of conservation tillage that leaves crop residue on the surface and stripcropping help to control water erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

The key range plants on these soils are western wheatgrass, green needlegrass, and big bluestem. Crested and intermediate wheatgrass, smooth bromegrass, and alfalfa are suitable hay and pasture plants. If the range is overgrazed, water erosion is a hazard. It can be controlled by maintaining an adequate cover of the key plants. Gullies can form along cattle trails. Cross fences that control the pattern of livestock traffic help to prevent gullying.

The Williams soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Bowbells soil is suited to all climatically adapted species. It has no critical limitations. Eliminating grasses and weeds before the trees and shrubs are planted and controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings.

These soils are suited to septic tank absorption fields and buildings. The moderately slow permeability is a limitation in septic tank absorption fields, but it can be overcome by enlarging the field. The shrink-swell potential is a limitation on building sites, but installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling.

The land capability classification is IIe. The productivity index for spring wheat is 78.

69C—Maddock-Serden loamy fine sands, 3 to 9 percent slopes. These deep, undulating and gently rolling, hummocky soils are on glacial outwash plains mantled with eolian material. The well drained Maddock soil is on low knobs and hummocks. The excessively drained Serden soil is on knobs and ridges. Individual areas range from about 10 to more than 1,000 acres in size. They are about 35 to 70 percent Maddock soil and 20 to 60 percent Serden soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the surface soil of the Maddock soil is loamy fine sand about 14 inches thick. It is black in the upper part and very dark grayish brown in the lower part. The substratum to a depth of about 60 inches is olive brown fine sand. It is mottled between depths of 48 and 60 inches. In some areas the surface layer is loamy sand or fine sandy loam.

Typically, the Serden soil has a very dark gray loamy fine sand surface layer about 4 inches thick. The next layer is very dark grayish brown fine sand about 3 inches thick. The substratum to a depth of about 60 inches is dark grayish brown fine sand. In some places the surface layer is loamy sand or fine sand. In other places it is calcareous.

Included with these soils in mapping are small areas of Arveson, Arvilla, and Ulen soils. These included soils make up about 5 to 10 percent of the unit. The poorly drained Arveson soils are in depressions. They have a loam surface layer and are highly calcareous. Arvilla soils have a coarse sand substratum. They occur as areas intermingled with areas of the Maddock and Serden soils. The somewhat poorly drained Ulen soils are in swales. They are highly calcareous. Also included are areas of blown-out land less than 1 acre in size.

Permeability is rapid in the Maddock and Serden soils, and runoff is very slow. Available water capacity is low. Organic matter content is moderately low in the Maddock soil and low in the Serden soil.

Most areas are used as range. Because of a severe hazard of soil blowing and the droughtiness, these soils are generally unsuited to wheat, oats, and barley. They are best suited to range. The key range plants are needleandthread, prairie sandreed, and sand bluestem. Intermediate and pubescent wheatgrass, smooth bromegrass, and alfalfa are suitable hay and pasture plants. Soil blowing and the low available water capacity are problems, especially if the range is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the key plants helps to control soil blowing and prevent denuding.

The Serden soil is suited to only a few of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The undulating areas of the Maddock soil are suited to many climatically adapted species, but it is droughty. The trees and shrubs commonly are affected by moisture stress. Supplemental watering helps to ensure the survival of seedlings. Little benefit is derived from fallowing the season prior to planting because of the low available water capacity. Eliminating grasses and weeds before the trees and shrubs are planted and controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

These soils are poorly suited to septic tank absorption fields and are suited to buildings. Because of the rapid permeability, they readily absorb but do not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity may result in the pollution of ground water. A mound system helps to prevent this pollution. The sides of shallow excavations, such as those for basements, tend to cave in unless they are shored.

The land capability classification is VIe. The productivity index for spring wheat is 0.

69E—Serden loamy fine sand, 3 to 35 percent slopes. This deep, undulating to steep, excessively drained soil is on glacial outwash plains mantled with sandy eolian material. The sandy material has been blown into ridges and hillocks, and the surface is hummocky. Individual areas range from about 20 to more than 400 acres in size.

Typically, the surface layer is very dark gray loamy fine sand about 4 inches thick. The next layer is very dark grayish brown fine sand about 3 inches thick. The substratum to a depth of about 60 inches is dark grayish brown fine sand. In some places the surface layer is fine sand or loamy sand. In other places a buried surface layer is in the substratum. In some areas the soil is mottled below a depth of about 40 inches.

Included with this soil in mapping are small areas of Arveson, Hecla, and Ulen soils. These soils make up about 5 to 35 percent of the unit. The poorly drained and very poorly drained Arveson soils are in depressions. They are highly calcareous. The moderately well drained Hecla soils are on flats and in swales. They are dark to a depth of more than 16 inches. The somewhat poorly drained Ulen soils are in swales. They are highly calcareous. Also included are small areas of blown-out land 0.25 acre to 10 acres in size.

Permeability is rapid in the Serden soil, and runoff is slow. Available water capacity and organic matter content are low.

Most areas are used as range and wildlife habitat. Because of a severe hazard of soil blowing, the droughtiness, and the slope, this soil generally is unsuited to cultivated crops. It is best suited to range and wildlife habitat. The key range plants are needleandthread and prairie sandreed. Soil blowing and the low available water capacity are problems, especially if the range is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the key plants helps to control soil blowing and prevent denuding.

Where slopes are undulating or gently rolling, this soil is suited to a few of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Because the soil is droughty, the trees and shrubs commonly are affected by moisture stress. Supplemental watering helps to ensure the survival of seedlings. Little benefit is derived from fallowing the season prior to planting because of the low available water capacity. Eliminating grasses and weeds before the trees and shrubs are planted and controlling the regrowth of this ground cover improves the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

This soil is poorly suited to septic tank absorption fields but is suited to buildings. Because of the rapid permeability, it readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity may result in the pollution of ground water. A mound system helps to prevent this pollution. The slope is a limitation on sites for buildings

and septic tank absorption fields, but it can be overcome by designing the buildings and absorption fields so that they conform to the natural slope of the land. The sides of shallow excavations, such as those for basements, tend to cave in unless they are shored.

The land capability classification is VIe. The productivity index for spring wheat is 0.

72B—Miranda loam, 0 to 6 percent slopes. This deep, level to undulating, moderately well drained, alkali soil is on glacial till plains. Individual areas range from about 10 to more than 100 acres in size.

Typically, the surface layer is black loam about 4 inches thick. The subsurface layer is very dark gray silt loam about 3 inches thick. The subsoil is clay loam about 50 inches thick. It is very dark grayish brown in the upper part, olive brown in the next part, and olive gray and mottled in the lower part. The substratum to a depth of about 60 inches is olive gray, mottled clay loam. In some places the surface layer is fine sandy loam or silty clay loam. In other places salts are in the surface layer. In some areas the soil has an exposed subsoil and supports no vegetation.

Included with this soil in mapping are small areas of Barnes soils, the saline Colvin soils, and Flaxton, Noonan, and Williams soils. These soils make up about 5 to 10 percent of the unit. The well drained Barnes, Flaxton, and Williams soils are higher on the landscape than the Miranda soil. They do not have a dense, alkali subsoil. The poorly drained Colvin soils are on flats. They are saline and highly calcareous. Noonan soils do not have a layer of accumulated gypsum or other salts within a depth of 16 inches. They are on scattered microknolls.

Permeability is very slow in the Miranda soil, and runoff is slow. Available water capacity is moderate. Salts in the soil reduce the amount of water available to plants. Organic matter content is moderately low. The dense, alkali subsoil restricts the depth to which plant roots can penetrate.

Most areas are used as range. Because of alkalinity and salinity, this soil generally is unsuited to cultivated crops, trees, shrubs, tame grasses, and legumes. It is best suited to range. The key range plants are western wheatgrass, blue grama, and buffalograss. The dense, alkali subsoil and the salts are limitations, especially if the range is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the key plants helps to protect the surface. Stock water ponds constructed in this soil sometimes contain salty water.

This soil is generally unsuited to septic tank absorption fields but is suited to buildings. Because of the very slow permeability, it generally is not used as a site for septic tank absorption fields. Better sites generally are nearby. The shrink-swell potential is a limitation on building sites, but installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling.

The land capability classification is VIs. The productivity index for spring wheat is 0.

74B—Williams-Noonan loams, 1 to 6 percent slopes. These deep, nearly level and undulating soils are on glacial till plains. The well drained Williams soil is on side slopes or on flats. The moderately well drained, alkali Noonan soil is on foot slopes or in swales. Individual areas range from about 10 to more than 200 acres in size. They are about 45 to 60 percent Williams soil and 35 to 50 percent Noonan soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Williams soil has a very dark brown loam surface layer about 7 inches thick. The subsoil is clay loam about 20 inches thick. It is dark grayish brown in the upper part and light olive brown in the lower part. The substratum to a depth of about 60 inches is grayish brown clay loam. In some places the subsoil does not have a layer of accumulated clay. In other places the dark color of the surface layer extends to a depth of more than 16 inches.

Typically, the Noonan soil has a very dark brown loam surface layer about 8 inches thick. The subsurface layer is very dark grayish brown loam about 3 inches thick. The subsoil is clay loam about 31 inches thick. It is dark grayish brown and brown in the upper part and dark grayish brown and mottled in the lower part. The substratum to a depth of about 60 inches is dark grayish brown, mottled clay loam. In some places the surface layer is silt loam or clay loam. In other places the subsoil is silty clay or clay.

Included with these soils in mapping are small areas of Flaxton, Miranda, Tonka, and Zahl soils. These included soils make up about 5 to 15 percent of the unit. Flaxton soils have a fine sandy loam surface layer. They occur as areas intermingled with areas of the Williams soil. Miranda soils have accumulated gypsum and other salts within a depth of 16 inches. They are lower on the landscape than the Williams and Noonan soils. The poorly drained Tonka soils are in depressions. Zahl soils are on low knolls. They have a calcareous subsoil.

Permeability is moderately slow in the Williams soil and slow in the Noonan soil. Runoff is medium on both soils. Available water capacity is high in the Williams soil and moderate in the Noonan soil. Organic matter content is moderate in both soils. Tilth is fair. The dense, alkali subsoil in the Noonan soil restricts the depth to which plant roots can penetrate.

Most areas are used as range. Some areas are used for cultivated crops. These soils are suited to wheat, oats, barley, flax, grasses, and legumes. The hazard of soil blowing is slight, and the hazard of water erosion is moderate. A system of conservation tillage that leaves

crop residue on the surface and stripcropping help to control water erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Growing alfalfa and managing crop residue increase the infiltration rate, improve tilth, and facilitate the penetration of roots in the dense, alkali subsoil of the Noonan soil.

The key range plants on these soils are western wheatgrass, needleandthread, green needlegrass, and blue grama. Pubescent wheatgrass and alfalfa are suitable hay and pasture plants. Water erosion is a hazard, especially if the range is overgrazed. Maintaining an adequate cover of the key plants helps to prevent excessive soil loss. Gullies can form along cattle trails. Cross fences that control the pattern of livestock traffic help to prevent gullying.

The Williams soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Noonan soil is suited to only the species that are drought and salt tolerant. Supplemental watering helps to ensure the survival of seedlings. Individual trees and shrubs on the Noonan soil vary in height, density, and vigor, which are affected by the restricted root development in the dense, alkali subsoil and the reduced amount of available water resulting from the salts in the soil.

These soils are suited to septic tank absorption fields and buildings. The Williams soil is better suited than the Noonan soil. The slow or moderately slow permeability is a limitation in septic tank absorption fields, but it can be overcome by enlarging the absorption field. The shrink-swell potential is a limitation on building sites, but installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling.

The land capability classification of the Williams soil is IIe, and that of the Noonan soil is IVs. The productivity index of both soils for spring wheat is 58.

76—Letcher fine sandy loam, 0 to 3 percent slopes. This deep, level and nearly level, somewhat poorly drained, alkali soil is on glacial till and lacustrine plains mantled with sandy material. Individual areas range from 5 to about 125 acres in size.

Typically, the surface soil is black fine sandy loam about 11 inches thick. The subsurface layer is very dark gray fine sandy loam about 2 inches thick. The subsoil is about 29 inches thick. It is very dark grayish brown fine sandy loam in the upper part; dark brown, mottled loamy sand in the next part; and light yellowish brown, mottled fine sandy loam in the lower part. The upper part of the substratum is dark grayish brown, mottled sandy loam. The lower part to a depth of about 60 inches is dark gray silty clay. In some places the surface layer is loam or sandy loam. In other places the clayey substratum is at a depth of 30 to 40 inches.

Included with this soil in mapping are small areas of Arveson, Colvin, Embden, Flaxton, and Towner soils. These soils make up about 15 to 30 percent of the unit. The poorly drained Arveson and very poorly drained Colvin soils are in depressions and drainageways. They are highly calcareous. The moderately well drained Embden and Towner and well drained Flaxton soils are on slight rises. They do not have a dense, alkali subsoil.

Permeability is slow in the Letcher soil. Runoff also is slow. Available water capacity is moderate. A seasonal high water table is at a depth of 3.5 to 6.0 feet. Organic matter content is moderate. Tilth is fair. The dense, alkali subsoil restricts the depth to which plant roots can penetrate.

Most areas are cultivated. This soil is poorly suited to cultivated crops. Because root penetration is restricted in the dense, alkali subsoil, moisture stress restricts crop growth in most years. Surface crusting inhibits seedling emergence of some crops. Deferring tillage when the soil is either too wet or too dry helps to limit surface crusting and clodding and results in a better seedbed. The hazard of soil blowing is severe, and the hazard of water erosion is slight. A system of conservation tillage that leaves crop residue on the surface, windbreaks, and buffer strips help to control soil blowing. Growing alfalfa and managing crop residue increase the infiltration rate, improve tilth, and facilitate the penetration of roots in the dense, alkali subsoil.

The key range plants on this soil are needleandthread and little bluestem. Wheatgrasses, smooth bromegrass, and alfalfa are suitable hay and pasture plants. Soil blowing and the moderate available water capacity are problems, especially if the range is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the key plants helps to control soil blowing and prevent denuding.

This soil is suited to only a few of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The only species that grow well are those that are drought and salt tolerant. Supplemental watering helps to ensure the survival of seedlings. Individual trees and shrubs vary in height, density, and vigor, which are affected by the restricted root development in the dense, alkali subsoil and the reduced amount of available water resulting from the salts in the soil. Strips of an annual cover crop between the rows help to control soil blowing and protect the seedlings from abrasion.

This soil is poorly suited to septic tank absorption fields and buildings because of the seasonal high water table and the slow permeability. A mound system helps to overcome these limitations in septic tank absorption fields. The shrink-swell potential is a limitation on building sites, but installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage

caused by shrinking and swelling. The drainage system also helps to prevent seepage into basements.

The land capability classification is IVs. The productivity index for spring wheat is 31.

92E—Buse-Barnes loams, 9 to 35 percent slopes. These deep, well drained soils are on glacial till plains and moraines dissected by drainageways. The rolling and hilly Barnes soil is on side slopes and summits. The rolling to steep Buse soil is on ridges, shoulder slopes, and breaks to drainageways. Individual areas range from about 10 to more than 1,000 acres in size. They are about 45 to 60 percent Buse soil and 30 to 45 percent Barnes soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Buse soil has a very dark gray loam surface layer about 7 inches thick. The subsoil is grayish brown loam about 11 inches thick. The substratum to a depth of about 60 inches is light olive brown clay loam. In some places the surface layer is lighter colored and is only 3 to 6 inches thick. In other places it is gravelly loam or cobbly loam.

Typically, the Barnes soil has a black loam surface layer about 5 inches thick. The subsoil is loam about 41 inches thick. In sequence downward, it is very dark grayish brown, dark grayish brown, grayish brown, and olive brown. The substratum to a depth of about 60 inches is light olive brown clay loam. In some areas the soil has a very dark brown surface layer and has a layer of accumulated clay in the subsoil.

Included with these soils in mapping are small areas of Miranda, Parnell, Sioux, Svea, and Vebar soils. These included soils make up about 5 to 20 percent of the unit. Miranda soils are in drainageways. They have a dense, alkali subsoil and have accumulated gypsum or other salts within a depth of 16 inches. The very poorly drained Parnell soils are in depressions. They have a silty clay loam surface layer. The excessively drained Sioux soils are on ridges. They are shallow to very gravelly sand. The moderately well drained Svea soils are in swales. They are dark to a depth of more than 16 inches. Vebar soils are on the crests of hills and on steep side slopes. They have a fine sandy loam surface layer and subsoil and are underlain by soft sandstone at a depth of 20 to 40 inches. Also included are some stony or bouldery areas.

Permeability is moderately slow in the Buse and Barnes soils, and runoff is very rapid. Available water capacity is high. Organic matter content is high in the Barnes soil and moderately low in the Buse soil.

Most areas are used as range. Because of a severe hazard of water erosion on both soils, a moderate hazard of soil blowing on the Buse soil, and the slope of both soils, this unit is generally unsuited to wheat, oats, and barley. The key range plants are little bluestem, needlegrass, and western wheatgrass. Soil blowing and water erosion are hazards, especially if the range is overgrazed. Reestablishing vegetation is difficult in denuded areas. The slope limits the use of machinery. Maintaining an adequate cover of the key plants helps to control soil blowing and water erosion and prevent denuding.

These soils are generally unsuited to the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Trees and shrubs can be grown for esthetic purposes or to enhance wildlife habitat if special management, such as hand or scalp planting, is applied.

These soils are poorly suited to septic tank absorption fields and buildings. The moderately slow permeability is a limitation in septic tank absorption fields, but it can be overcome by enlarging the field. The shrink-swell potential is a limitation on building sites, but installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling. The slope is a limitation in septic tank absorption fields and on building sites, but it can be overcome by designing the buildings and absorption fields so that they conform to the natural slope of the land.

The land capability classification of the Buse soil is VIIe, and that of the Barnes soil is VIe. The productivity index of both soils for spring wheat is 0.

93E—Vebar-Williams complex, 9 to 35 percent slopes. These steep, well drained soils are on uplands mantled with glacial till. The moderately deep, rolling to steep Vebar soil is on narrow ridges, shoulder slopes, and the upper side slopes. The deep, rolling and hilly Williams soil is on the upper side slopes and on the summits of ridges. Individual areas are about 25 to 1,500 acres in size. They are about 35 to 70 percent Vebar soil and 15 to 30 percent Williams soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Vebar soil has a very dark grayish brown fine sandy loam surface layer about 5 inches thick. The subsoil is fine sandy loam about 15 inches thick. It is very dark grayish brown in the upper part and dark grayish brown in the lower part. The substratum is dark grayish brown loamy fine sand about 11 inches thick. Soft sandstone bedrock is at a depth of about 31 inches. In some places the surface layer is loam. In other places the depth to bedrock is more than 40 inches or is 10 to 20 inches. In some areas the dark color of the surface layer extends to a depth of more than 16 inches.

Typically, the Williams soil has a very dark brown loam surface layer about 6 inches thick. The subsoil is dark brown clay loam about 7 inches thick. The substratum to a depth of about 60 inches is olive brown clay loam. In some places the dark color of the surface layer extends to a depth of more than 16 inches. In other places the surface layer is fine sandy loam.

Included with these soils in mapping are small areas of Arvilla, Miranda, Noonan, and Sioux soils. These included soils make up about 15 to 35 percent of the unit. The somewhat excessively drained Arvilla soils have a coarse sand substratum. They are lower on the landscape than the Vebar and Williams soils. The moderately well drained Miranda and Noonan soils have a dense, alkali subsoil. Miranda soils are in drainageways, and Noonan soils are on small flats. The excessively drained Sioux soils are on ridges and hilltops. They have a very gravelly sand substratum. Also included are some stony areas and areas where bedrock crops out.

Permeability is moderately rapid in the Vebar soil and moderately slow in the Williams soil. Runoff is very rapid on both soils. Available water capacity is high in the Williams soil and low in the Vebar soil. Organic matter content is moderate in the Williams soil and moderately low in the Vebar soil.

Most areas are used as range. Because of a severe hazard of water erosion on both soils, the slope of both soils, and a severe hazard of soil blowing on the Vebar soil, this unit is generally unsuited to wheat, oats, barley, trees, and shrubs. It is best suited to range. The key range plants are needleandthread, prairie sandreed, western wheatgrass, and little bluestem. Soil blowing and water erosion are hazards, especially if the range is overgrazed. Reestablishing vegetation is difficult in denuded areas. The slope limits the use of machinery. Maintaining an adequate cover of the key plants helps to control soil blowing and water erosion.

These soils are poorly suited to septic tank absorption fields and buildings because of the slope. In this survey area, they are generally not used as building sites or absorption fields. Better sites are generally nearby.

The land capability classification of the Vebar soil is VIIe, and that of the Williams soil is VIe. The productivity index of both soils for spring wheat is 0.

Prime Farmland

Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture. It is of major importance in meeting the Nation's short- and long-range needs for food and fiber. Because the supply of high quality farmland is limited, the U.S. Department of Agriculture recognizes that responsible levels of government, as well as individuals, should encourage and facilitate the wise use of our Nation's prime farmland.

Prime farmland, as defined by the U.S. Department of Agriculture, is the land that is best suited to food, feed, forage, fiber, and oilseed crops. It may be cultivated land, pasture, woodland, or other land, but it is not urban and built-up land or water areas. It either is used for food or fiber crops or is available for those crops. The soil qualities, growing season, and moisture supply are those needed for a well managed soil to produce a sustained high yield of crops in an economic manner. Prime farmland produces the highest yields with minimal inputs of energy and economic resources, and farming it results in the least damage to the environment.

Prime farmland has an adequate and dependable supply of moisture from precipitation or irrigation. The temperature and growing season are favorable. The level of acidity or alkalinity is acceptable. Prime farmland has few or no rocks and is permeable to water and air. It is not excessively erodible or saturated with water for long periods and is not frequently flooded during the growing season. The slope ranges mainly from 0 to 6 percent. More detailed information about the criteria for prime farmland is available at the local office of the Soil Conservation Service.

About 75,410 acres in the survey area, or more than 8 percent of the total acreage, meets the soil requirements for prime farmland. Scattered areas of this land are throughout the county, but most are in the eastern and northern parts, mainly in associations 1 and 6, which are described under the heading "General Soil Map Units." Most of this prime farmland is used for crops. The crops grown on this land, mainly wheat and other small grain, account for a large share of the county's total agricultural income each year.

The map units in the survey area that are considered prime farmland are listed in this section. This list does not constitute a recommendation for a particular land use. The extent of each listed map unit is shown in table 4. The location is shown on the detailed soil maps at the back of this publication. The soil qualities that affect use and management are described under the heading "Detailed Soil Map Units."

Some soils that have a seasonal high water table qualify for prime farmland only in areas where this limitation has been overcome by drainage measures. The need for these measures is indicated after the map unit name on the following list. Onsite evaluation is needed to determine whether or not this limitation has been overcome by corrective measures.

The map units that meet the requirements for prime farmland are:

3	Marysland loam (where drained)
7	Arveson-Ulen complex, 0 to 3 percent slopes (where drained)
14	Tonka loam (where drained)
20	Colvin silt loam (where drained)
22B	Barnes-Svea loams, 1 to 6 percent slopes
32	Overly silt loam, 0 to 3 percent slopes
37	Divide loam, 0 to 3 percent slopes
39	Embden fine sandy loam, 1 to 3 percent slopes
44	Fordville loam, 0 to 3 percent slopes
52	Hamerly loam, 0 to 3 percent slopes
61	Nutley silty clay, 1 to 3 percent slopes
61B	Nutley silty clay, 3 to 6 percent slopes

Use and Management of the Soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as range; for windbreaks; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

Crops and Pasture

Lyle Samson, agronomist, and Wayne Moen, district conservationist, Soil Conservation Service, helped prepare this section.

General management needed for crops and pasture is suggested in this section. The crops best suited to the soils including some not commonly grown in the survey area are identified; a number of adapted pasture plants are listed in each map unit; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are listed for each soil. The crops best suited to the soils

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed Soil Map Units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

More than 421,000 acres in Kidder County was used for crops and hay in 1982 (*4*). Of this total 181,400 acres was used for close-grown small grain, 37,600 acres for row crops, and 162,000 acres for alfalfa and other hay. About 40,000 acres was summer fallowed. About 7,080 acres was irrigated cropland. Since 1980, the acreage used for close-grown crops has been increasing and the acreage that is pastured or summer fallowed has been decreasing.

Wheat, barley, oats, sunflowers, flax, legumes, corn for silage, and tame grasses generally are suited to the soils and climate in the county and are grown in many areas. Crops that are not commonly grown but are suitable include dry edible beans, soybeans, potatoes, rapeseed, and mustard.

The potential of the soils in Kidder County for increased production of food and fiber is good. Production could be increased by extending the latest crop production technology to all cropland in the county. This soil survey can facilitate the application of such technology.

The main concerns in managing the cropland and pasture in the county are controlling soil blowing and water erosion, conserving moisture, and maintaining fertility. Clean-tilled areas used for sunflowers are particularly erosive.

Soil blowing is a hazard on nearly all soils in the county. It is most severe on Arvilla, Embden, Flaxton, Hecla, Maddock, Serden, Towner, and Vebar soils. It can damage the soils in a very short time if winds are strong and the soils are dry and have no plant cover or surface mulch. Water erosion is a hazard on the undulating or steeper soils, such as Barnes, Buse, Williams and Zahl. Cover crops, wind stripcropping, buffer strips, field windbreaks, contour stripcropping, diversions and grassed waterways, conservation tillage, a cropping sequence that includes grasses and legumes, and crop residue management help to control soil blowing and

water erosion. A combination of these generally is needed.

Moisture generally is conserved by measures that reduce evaporation and runoff rates, increase the rate of water infiltration, and control weeds. Examples are stubble mulching, conservation tillage, a cropping sequence that includes grasses and legumes, field windbreaks, buffer strips, cover crops, and crop residue management. In areas where summer fallowing helps to carry moisture over to the next season, stubble is needed on the surface throughout the winter to prevent excessive moisture loss and erosion. Weed control helps to prevent depletion of the moisture supply.

Measures that improve fertility are needed on some soils. Examples are applications of commercial fertilizer or barnyard manure, green manure crops, and a cropping sequence that includes legumes.

Proper management of soils includes measures that maintain tilth. These measures are especially needed in Nutley soils and other soils that have a surface layer of silty clay. Measures that prevent excessive erosion and thus a reduction in the content of organic matter are very important in maintaining good tilth. The traditional practice of clean tillage reduces the organic matter content because it results in erosion.

Other problems in soil management are salinity; a dense, alkali subsoil; surface stones; and wetness. Areas where salinity is a problem should not be summer fallowed. The effects of salinity also can be reduced by growing the most salt tolerant crops, including grasses and legumes in the cropping sequence, and growing green manure crops. Deep tillage can temporarily break up the dense, alkali subsoil in Cresbard and Noonan soils. The subsoil can be more permanently improved by growing deep-rooted grasses and legumes and by incorporating green manure crops into the soil.

Further information about the management and crops described in this section can be obtained from local offices of the Cooperative Extension Service and the Soil Conservation Service.

Yields Per Acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 5. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green manure crops; and harvesting that ensures the smallest possible loss.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 5 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils for those crops.

Productivity Index

The productivity index is a relative rating of the ability of a particular map unit to produce a particular crop yield in comparison to other map units. The index ranges from 0, which indicates no yield, to 100, which indicates the highest yield. When the index is calculated, the similar and contrasting inclusions are considered as well as the soils specified in the name of the map unit. In Kidder County a productivity index of 100 was considered equal to an average yield of 37 bushels per acre of spring wheat. Multiplying the productivity index by 37 and then dividing the product by 100 will convert the index number to a figure representing the expected yield per acre. Flaxton fine sandy loam, 1 to 6 percent slopes, for example, has a productivity index of 69, which when multiplied by 37 and then divided by 100, converts to 26, which is the expected annual spring wheat yield in bushels per acre for this map unit. (See table 5.)

The highest yield of spring wheat is 40 bushels on the Central Black Glaciated Plains and 34 bushels on the Central Dark Brown Glaciated Plains. The average of these two yields, that is, 37 bushels, was used in determining the equivalent of a productivity index of 100 in Kidder County.

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The criteria used in grouping the soils do not include major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor do they include possible but unlikely major reclamation projects. Capability classification is not a substitute for

interpretations designed to show suitability and limitations of groups of soils for rangeland, for woodland, and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit. Only class and subclass are used in this survey.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, range, woodland, wildlife habitat, or recreation.

The capability classification of each map unit is given in the section "Detailed Soil Map Units."

Rangeland

This section was prepared by Leonard Jurgens, range conservationist, Soil Conservation Service.

In areas that have similar climate and topography, differences in the kind and amount of vegetation produced on rangeland are closely related to the kind of soil. Effective management is based on the relationship between the soils and vegetation and water.

The native vegetation on rangeland consists of a wide variety of grasses, grasslike plants, forbs, shrubs, and trees. Generally, the plants are suitable for grazing and the plant cover is sufficiently productive to justify grazing. Cultural treatments generally are not used to increase forage production. The composition and production of the plant community are determined by soil, climate, topography, overstory canopy, and grazing management.

In 1983, approximately 275,000 acres in Kidder County, or about 30 percent of the total acreage, was rangeland. In areas where it is properly managed, this rangeland is similar to the presettlement prairie of the late 1800's and early 1900's. Most of the rangeland is on loamy glacial till plains and moraines and sandy and loamy glacial lake plains and outwash plains. Much of it occurs as rolling to steep soils or level, wet soils. The soils are generally unsuited or poorly suited to cultivated crops.

In 1983, the farms and ranches in the county had about 83,000 head of cattle. Of that number, about 3,000 were milk cows (*4*). Most of the ranches include a cow-calf operation. A number also include a yearling operation, which adds flexibility during periods of low or high forage production. On some ranches used for a cow-calf operation, sheep are raised for improved income stability.

Because of the relatively short growing season, many farmers and ranchers have established cool-season tame pastures to supplement the forage produced on rangeland and to extend the grazing season in the spring and fall. Droughts of short duration are common. As a result, cool-season pastures cannot be grazed in the fall in many years. Generally, large amounts of hay and feed are needed because of the long winters. Hay was harvested on about 187,000 acres in 1982 (*4*).

Range Site and Condition Classes

Soils vary in their capacity to produce grasses and other plants suitable for grazing. Soils that produce about the same kinds and amounts of forage are grouped into a range site.

Each range site has a distinctive potential plant community that is referred to as the climax vegetation. The climax vegetation is relatively stable and indicates what the range site is capable of producing. It reproduces itself annually and changes very little as long as the environment remains unchanged. On the prairie the climax vegetation consists of the kinds of plants that grew when the region was settled. It is generally the most productive combination of forage plants that can be grown on the site. When the site is grazed, some of the climax vegetation decreases in extent and some of it increases. Also, other plants invade the site.

Decreaser plants are the species that decline in quantity under close, continuous grazing. They generally are the tallest and most productive grasses and forbs and are the most palatable to livestock.

Increaser plants are the species that increase in quantity under close grazing at the expense of the decreaser species. They generally are the shorter plants or the ones less palatable to livestock.

Invader plants are species normally not included in the climax plant community because they cannot compete with the climax vegetation for moisture, nutrients, and light. They invade the site only after the extent of the climax vegetation has been reduced by heavy continual grazing. Most invader species have little grazing value.

Range condition classes indicate the present composition of the plant community on a range site in relation to the climax vegetation. Range condition is expressed as excellent, good, fair, or poor, depending on how much the present plant community has departed from the climax. *Excellent* indicates that 76 to 100 percent of the present plant community is the same as the climax vegetation; *good*, 51 to 75 percent; *fair*, 26 to 50 percent; and *poor*, 25 percent or less.

Potential forage production depends on the kind of range site. Current forage production depends on the range condition and the amount of moisture available to the plants during the growing season.

Table 6 shows, for nearly all the soils in the county, the range site and the potential annual production of vegetation in favorable, average, and unfavorable years. Only those soils that are used as rangeland or are suited to use as rangeland are listed. An explanation of the column headings in table 6 follows.

A *range site* is a distinctive kind of rangeland that produces a characteristic natural plant community that differs from natural plant communities on other range sites in kind, amount, and proportion of range plants. The relationship between soils and vegetation was ascertained during this survey; thus, range sites generally can be determined directly from the soil map. Soil properties that affect moisture supply and plant nutrients have the greatest influence on the productivity of range plans. Soil reaction, salt content, and a seasonal high water table are also important.

Potential annual production is the amount of vegetation that can be expected to grow annually on well managed rangeland that is supporting the potential natural plant community. It includes all vegetation, whether or not it is palatable to grazing animals. It includes the current year's growth of leaves, twigs, and fruits of woody plants. It does not include the increase in stem diameter of trees and shrubs. It is expressed in pounds per acre of air-dry vegetation for favorable, average, and unfavorable years. In a favorable year, the amount and distribution of precipitation and the temperatures make growing conditions substantially better than average. In an unfavorable year, growing conditions are well below average, generally because of low available soil moisture.

Yields are adjusted to a common percent of air-dry moisture content. The relationship of green weight to air-dry weight varies according to such factors as exposure, amount of shade, recent rains, and unseasonable dry periods.

Range management requires a knowledge of the kinds of soil and of the potential natural plant community. It also requires an evaluation of the present range condition. Range condition is determined by comparing the present plant community with the potential natural plant community on a particular range site. The more closely the existing community resembles the potential community, the better the range condition. Range condition is an ecological rating only.

The objective in range management is to control grazing so that the plants growing on a site are about the same in kind and amount as the potential natural plant community for that site. Such management generally results in the optimum production of vegetation, control of undesirable brush species, conservation of water, and control of erosion. Sometimes, however, a range condition somewhat below the potential meets grazing needs, provides wildlife habitat, and protects soil and water resources.

Good range management keeps the range in excellent or good condition. Water is conserved, yields are improved, and soils are protected. The main management concern is recognizing the changes in the plant community that take place gradually and can be misinterpreted or overlooked. Growth encouraged by heavy rainfall, for example, may lead to the conclusion that the range is in good condition, when actually the plant cover is weedy and the long-term trend is toward lower production. On the other hand, some rangeland that has been grazed closely for a short period may have a degraded appearance that temporarily obscures its quality and ability to recover rapidly.

Rangeland can recover from prolonged overuse if the climax decreaser species have not been completely grazed out. If overgrazing is stopped, enough climax plants generally remain for proper grazing use, deferred grazing, and the grazing system to restore the rangeland to an excellent condition. In areas where the climax plant community has been destroyed, range seeding can improve the condition. Seeding the proper climax species also can restore productive rangeland in areas of poor-quality cropland. Brush control, development of watering facilities, and other mechanical practices are needed to improve the potential of some rangeland. Fencing is one of the most overlooked means of improving rangeland.

The following paragraphs describe the range sites in Kidder County. The names of these sites are Clayey, Claypan, Limy Subirrigated, Overflow, Saline Lowland, Sands, Sandy, Shallow to Gravel, Silty, Subirrigated, Thin

Claypan, Thin Sands, Thin Upland, Very Shallow, Wetland, and Wet Meadow.

Clayey range site. This site is dominated by a mixture of cool-season, mid grasses and an understory of short grasses. The principal species are western wheatgrass, porcupinegrass, needleandthread, and green needlegrass. The understory plants are blue grama, prairie junegrass, Pennsylvania sedge, and other upland sedges. Forbs, such as western yarrow, scarlet globemallow, and gray sagewort, make up about 5 percent of the total herbage. The common woody plants are fringed sagebrush, western snowberry, and prairie rose.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as western wheatgrass, porcupinegrass, needleandthread, green needlegrass, and prairie junegrass. The plants that increase in abundance under these conditions are blue grama, fringed sagebrush, Kentucky bluegrass, and upland sedges. Further deterioration results in a dominance of blue grama, Kentucky bluegrass, upland sedges, western ragweed, and fringed sagewort.

Very few problems affect management of this site. The water infiltration rate is slow. As a result, an adequate cover of vegetation is needed to help ensure that forage production is not reduced by runoff. Areas where the range is in poor or fair condition can generally be restored to good or excellent condition by good management of the remnant climax species.

Claypan range site. The climax vegetation on this site is primarily a mixture of short and mid grasses, sedges, and forbs. The principal species are western wheatgrass, green needlegrass, needleandthread, and prairie junegrass. Other species are blue grama and upland sedges. The common forbs are scarlet globemallow, silver scurfpea, and rush skeletonplant. The common shrubs are fringed sagebrush and broom snakeweed.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as green needlegrass, prairie junegrass, needleandthread, and western wheatgrass. The plants that increase in abundance under these conditions are inland saltgrass, blue grama, Sandberg bluegrass, upland sedges, and fringed sagebrush. Further deterioration results in a dominance of blue grama, inland saltgrass, upland sedges, fringed sagebrush, and unpalatable forbs.

This site is easily damaged by overgrazing. Because of a dense subsoil and the content of salts in the soil, reestablishing the vegetation is difficult in denuded areas. Careful management that maintains the abundance of the key plants is the best way to maintain forage production and protect the soil from water erosion.

Limy Subirrigated range site. Tall grasses dominate this site. The principal species are little bluestem, big bluestem, indiangrass, and switchgrass. Other species are slim sedge, fescue sedge, and Baltic rush. The common forbs are Maximilian sunflower, stiff sunflower, American licorice, and Missouri goldenrod. They make up about 10 percent of the total herbage.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as big bluestem, indiangrass, switchgrass, Maximilian sunflower, and stiff sunflower. Little bluestem initially increases in abundance under these conditions, but it eventually decreases. Further deterioration results in a dominance of Kentucky bluegrass, Baltic rush, common spikerush, and low-growing sedges, grasses, and forbs.

Because of the high percentage of warm-season grasses, this site can provide high-quality forage late in the growing season. In areas where the plant community has deteriorated from its potential, deferment of grazing during the growing season or a planned grazing system can restore the site. In areas where the potential plant community has been destroyed by cultivation or by extremely severe overuse, range seeding can reestablish the major grass species.

Overflow range site. Both tall and mid grasses are dominant when this site in excellent condition. The principal species are big bluestem, green needlegrass, western wheatgrass, and needleandthread. Other species are porcupinegrass, switchgrass, fescue sedge, little bluestem, and Kentucky bluegrass. Several forbs, such as Maximilian sunflower, soft goldenrod, gray sagewort, and heath aster, make up about 10 percent of the total herbage. Several woody plants, such as western snowberry, fringed sagebrush, and common chokecherry, commonly grow on the site, depending on the position on the landscape. They may make up about 5 percent of the total herbage.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as big bluestem, green needlegrass, prairie dropseed, and switchgrass. The plants that increase in abundance under these conditions are western wheatgrass, blue grama, Pennsylvania sedge, fescue sedge, and Kentucky bluegrass. Further deterioration results in a dominance of blue grama, sedges, and unpalatable forbs.

Because of its position on the landscape, this site is frequently overgrazed. Fencing generally is not feasible because of the small size or the shape of areas of this site. As a result of flooding and the runoff received by these areas, this is a very productive site when properly managed. A planned grazing system can restore the site and maintain a high level of productivity. Reseeding is needed in areas that have been farmed. In areas where shrubs dominate, brush control can help to restore productivity.

Saline Lowland range site. Salt-tolerant, mid grasses dominate this site. The principal species are Nuttall alkaligrass, inland saltgrass, alkali cordgrass, and salt-tolerant species of western wheatgrass and slender wheatgrass. Other species are alkali muhly, plains bluegrass, foxtail barley, and prairie bulrush. Forbs, such as western dock, silverweed cinquefoil, and Pursh seepweed, make up about 10 percent of the total herbage.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as Nuttall alkaligrass, slender wheatgrass, western wheatgrass, and alkali cordgrass. The plants that increase in abundance under these conditions are inland saltgrass, alkali muhly, foxtail barley, and mat muhly. Further deterioration results in a dominance of inland saltgrass, foxtail barley, silverweed cinquefoil, and western dock.

A high content of salts and a restricted available water capacity limit forage production on this site. Careful management of the adapted salt-tolerant plants can maintain good forage production. If the plant community has been severely damaged, however, the site recovers slowly. Soil blowing and water erosion are hazards in denuded areas. Stock water ponds on this site frequently contain salty water. If feasible, alternative water sources should be developed.

Sands range site. The principal grasses on this site are prairie sandreed, needleandthread, sand bluestem, and sand dropseed. Other species are blue grama, prairie junegrass, little bluestem, sand dropseed, western wheatgrass, and upland sedges. Forbs make up about 10 percent of the total herbage. This site has a small amount of woody species, such as prairie rose, western snowberry, and leadplant amorpha.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as prairie sandreed, needleandthread, little bluestem, sand bluestem, and leadplant amorpha. The plants that increase in abundance under these conditions are sand dropseed, blue grama, upland sedges, and several forbs. Further deterioration results in a dominance of blue grama, upland sedges, and unpalatable forbs, such as fringed sagewort and gray sagewort.

A low or very low available water capacity and the hazard of soil blowing are concerns in managing this site. Measures that minimize the formation of livestock trails and that do not allow the animals to concentrate in an area for too long a time are needed. In severely overgrazed areas, blowouts are common. On large blowouts, shaping, seeding, and mulching are needed before the climax vegetation can be reestablished. The vegetation in areas where the site is in fair or poor condition responds rapidly to improved grazing management.

Sandy range site. The principal grasses on this site are needleandthread and prairie sandreed. Other species are prairie junegrass, blue grama, western wheatgrass, green needlegrass, and upland sedges. The site generally has a number of early season forbs, such as western yarrow, green sagewort, and Missouri goldenrod. Woody plants, such as western snowberry and leadplant amorpha, make up about 5 percent of the total herbage.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as needleandthread, green needlegrass, prairie sandreed, and leadplant amorpha. The plants that increase in abundance under these conditions are blue grama, upland sedges, sand dropseed, and several forbs. Further deterioration results in a dominance of blue grama, upland sedges, and unpalatable forbs, such as western yarrow, green sagewort, and gray sagewort.

A low or moderate available water capacity is a concern in managing this site. Also, soil blowing is a hazard in denuded areas. Management that maintains the abundance of the key species results in a natural plant community that provides excellent forage for livestock and a protective plant cover.

Shallow to Gravel range site. A mixture of cool- and warm-season, mid grasses dominates this site. The principal species are western wheatgrass, needleandthread, green needlegrass, and blue grama. Other species are plains muhly, prairie junegrass, red threeawn, porcupinegrass, and upland sedges. Forbs make up about 10 percent of the total herbage. The site has only a small amount of woody plants.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as green needlegrass, western wheatgrass, plains muhly, and prairie junegrass. The plants that increase in abundance under these conditions are blue grama, Kentucky bluegrass, red threeawn, and upland sedges. Further deterioration results in a dominance of blue grama, upland sedges, unpalatable forbs, and fringed sagebrush.

Because of a limited available water capacity, forage production is limited on this site. It varies, depending on rainfall patterns. The site is fragile, and the plant community can deteriorate rapidly. Because of the limited amount of available water, the plant community should be kept near its potential.

Silty range site. Mid grasses dominate this site. The principal species are western wheatgrass, needleandthread, green needlegrass, and blue grama. Other species are prairie junegrass, prairie dropseed, Kentucky bluegrass, and upland sedges. Forbs make up about 10 percent of the total herbage. The site has minor amounts of weedy species.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as green needlegrass, prairie junegrass, needleandthread, and porcupinegrass.

The plants that increase in abundance under these conditions are western wheatgrass, blue grama, Kentucky bluegrass, threadleaf sedge, needleleaf sedge, and fringed sagebrush. Further deterioration results in a dominance of blue grama, threadleaf sedge, needleleaf sedge, and varying amounts of fringed sagebrush, gray sagewort, and other forbs.

Generally, no major problems affect management of this site. In the more sloping areas, however, gullies can form along livestock trails. Fencing and improved grazing management help to prevent gullying. They are also beneficial in areas where gullies have already formed. Areas where the site is in poor or fair condition generally can be restored to good or excellent condition by good management. In some areas brush control is needed.

Subirrigated range site. Tall grasses dominate this site. The principal species are big bluestem, switchgrass, prairie cordgrass, little bluestem, and northern reedgrass. Other species are indiangrass, western wheatgrass, tall dropseed, slender wheatgrass, and Kentucky bluegrass. The site has minor amounts of sedges and rushes. A variety of forbs makes up about 10 percent of the total herbage.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as big bluestem, switchgrass, prairie cordgrass, northern reedgrass, indiangrass, and little bluestem. The plants that increase in abundance under these conditions are mat muhly, fowl bluegrass, Kentucky bluegrass, Baltic rush, common spikerush, and undesirable forbs. Further deterioration results in a dominance of short grasses and grasslike plants and of undesirable forbs.

Because of the high percentage of warm-season grasses, this site can provide high-quality forage late in the growing season. In areas where the plant community has deteriorated from its potential, deferment of grazing during the growing season or a planned grazing system can restore the site. In areas where the potential plant community has been destroyed by cultivation or by extremely severe overuse, range seeding can reestablish the major grass species.

Thin Claypan range site. Short grasses dominate this site. The principal species are western wheatgrass, blue grama, inland saltgrass, and Sandberg bluegrass. Other species are prairie junegrass, needleandthread, Nuttall alkaligrass, alkali muhly, and needleleaf sedge. Forbs make up about 5 percent of the total herbage. The common woody plants are fringed sagebrush, broom snakeweed, and cactus.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as western wheatgrass, prairie junegrass, and needleandthread. Plants that increase in abundance under these conditions are blue grama, inland saltgrass, Sandberg bluegrass, and alkali muhly. Further deterioration results in a dominance of short grasses, sedges, fringed sagebrush, broom snakeweed, and undesirable forbs.

Because of a high content of salts near the surface, productivity is quite low on this site. The site produces good-quality forage for cattle only if properly managed. If the site is in poor or fair condition, recovery is quite slow because of the salts and a dense, alkali subsoil. Stock water pits should not be constructed on this site because the water is likely to be salty. Careful management can maintain or restore the site to good or excellent condition. If the vegetation has been destroyed by cultivation or the site denuded, range seeding can restore the climax vegetation. Good seeding techniques are needed.

Thin Sands range site. Mid grasses dominate this site. The principal species are prairie sandreed, needleandthread, and sand bluestem. Other species are blue grama, sand dropseed, Kentucky bluegrass, upland sedges, and prairie junegrass. Forbs make up about 10 percent of the total herbage. The site has minor amounts of woody plants.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as prairie sandreed, needleandthread, and sand bluestem. The plants that increase in abundance under these conditions are sand dropseed, Kentucky bluegrass, and upland sedges. Further deterioration results in a dominance of upland sedges, blue grama, and several unpalatable forbs.

This site is very fragile. It is subject to soil blowing if the vegetation is damaged by overgrazing or the soil is denuded. Blowouts are common in overgrazed areas. Good management can keep the site in good or excellent condition. In areas where the site is in poor or fair condition, careful management can restore productivity. A planned grazing system that includes adequate rest periods between the grazing periods is one of the better ways of managing this site.

Thin Upland range site. Mid, cool- and warm-season grasses dominate this site. The principal species are little bluestem, needleandthread, western wheatgrass, and blue grama. Other species are plains muhly, sideoats grama, red threeawn, Kentucky bluegrass, and upland sedges. Forbs make up about 10 percent of the herbage. The site has minor amounts of woody plants, such as silverberry and western snowberry.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as little bluestem, needleandthread, western wheatgrass, and sideoats grama. The plants that increase in abundance under these conditions are blue grama, red threeawn, Kentucky bluegrass, upland sedges, and unpalatable forbs. Further deterioration results in a dominance of blue grama, Kentucky bluegrass, upland sedges, and fringed sagebrush.

Generally, no major problems affect management of this site. In the more sloping areas, however, gullies can form along livestock trails. Fencing and improved grazing management help to prevent gullying. They are also beneficial in areas where gullies have already formed. Soil blowing is a problem in denuded areas. Areas where the site is in poor or fair condition generally can be restored to good or excellent condition by good management. In some areas brush control is needed.

Very Shallow range site. The site has a mixture of cool- and warm-season, mid grasses. The principal species are needleandthread, western wheatgrass, blue grama, and plains muhly. Other species are prairie junegrass, red threeawn, sideoats grama, and upland sedges. Forbs and woody plants make up about 10 percent of the total herbage.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as needleandthread, western wheatgrass, sideoats grama, and plains muhly. The plants that increase in abundance under these conditions are blue grama, red threeawn, sand dropseed, Kentucky bluegrass, and upland sedges. Further deterioration results in a dominance of blue grama, red threeawn, upland sedges, and undesirable forbs and shrubs.

Available water capacity is very low on this site. Also, water erosion is a hazard in the more sloping areas. Gullies can readily form along cattle trails and in denuded areas. The site is frequently overgrazed. Once it is in fair or poor condition, it recovers slowly because of the very low available water capacity. Productivity can be maintained by careful management of the cool-season, mid grasses and by cross fencing, which helps to control livestock traffic patterns.

Wetland range site. Tall grasses dominate this site. The principal species are rivergrass, prairie cordgrass, northern reedgrass, slough sedge, and slim sedge. Other species are American mannagrass, American sloughgrass, Baltic rush, and common spikesedge. Common forbs are longroot smartweed and waterparsnip.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as rivergrass, slough sedge, prairie cordgrass, and northern reedgrass. The plants that increase in abundance under these conditions are slim sedge, Baltic rush, common spikesedge, and American sloughgrass. Further deterioration results in a dominance of Baltic rush, common spikesedge, and Mexican dock.

This site is easily damaged when it is wet. Grazing during wet periods results in soil compaction, trampling, and root shearing. Livestock are attracted to this site because of the supply of moisture. A planned grazing system and deferment of grazing when the site is wet help to maintain the climax vegetation.

Wet Meadow range site. Mid sedges dominate this site. The principal species are slim sedge, wooly sedge, fescue sedge, prairie cordgrass, and northern reedgrass. Other species are Baltic rush, common spikerush, fowl bluegrass, and switchgrass. Common forbs are Rydberg sunflower, tall white aster, and common wild mint.

Continual heavy grazing by cattle results in a decrease in the abundance of of slim sedge, wooly sedge, northern reedgrass, prairie cordgrass, and switchgrass. The plants that increase in abundance under these conditions are fescue sedge, common spikerush, Baltic rush, mat muhly, and fowl bluegrass. Further deterioration results in a dominance of low-growing sedges, short grasses, western dock, and Canada thistle.

This site is easily damaged when it is wet. Grazing during wet periods results in compaction, trampling, and root shearing. Livestock are attracted to this site because of the supply of moisture. A planned grazing system and fencing help to maintain the climax vegetation. The site is an excellent source of quality hay.

Windbreaks and Environmental Plantings

Windbreaks protect livestock, buildings, and yards from wind and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field. The interval depends on the erodibility of the soil. Field windbreaks protect cropland and crops from wind, help to keep snow on the fields, and provide food and cover for wildlife.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To ensure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Table 7 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 7 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks and screens. Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from a commercial nursery.

Recreation

This section was prepared by Erling B. Podoll and David D. Dewald, biologists, Soil Conservation Service.

A number of towns in Kidder County have some basic facilities for recreational activities. Steele Park, Dawson Park, and the Slade National Wildlife Refuge have facilities for picnicking. Steele Park also has facilities for camping and golfing. At Lake George, Streeter Memorial State Park, in the southeastern part of the county, has facilities for camping, picnicking, boating, and swimming. About 10 other sites in the county have limited facilities for outdoor games, picnicking, or camping.

The county has a good distribution of land available for public use. This land includes 6,400 acres of national wildlife refuge, 6,000 acres of waterfowl-production areas, and 4,000 acres of state wildlife management areas. It is available for bird-watching, hiking, and cross-county skiing. Hunting is allowed in some areas but is restricted on the national wildlife refuge. Public access is available to two managed fishing lakes in the county.

The soils of the survey area are rated in table 8 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewerlines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 8, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 8 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 11 and interpretations for dwellings without basements and for local roads and streets in table 10.

Camp areas require site preparation, such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

Paths and trails for hiking and horseback riding should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Wildlife Habitat

This section was prepared by Erling B. Podoll and David D. Dewald, biologists, Soil Conservation Service.

Wildlife and fishery resources provide opportunities for hunting and fishing in Kidder County. About one-fourth of the adult population in the county hunts, and about one-third fishes. The U.S. Department of the Interior, Fish and Wildlife Service, has easements on 59,000 acres of wetland of all types in the county.

Wildlife numbers have been reduced substantially since settlement. Species composition has not changed drastically because a fair diversity of habitats has been retained. Important bird species include game birds, such as gray partridge, sharp-tailed grouse, pheasant, mourning dove, ducks, geese, and sandhill cranes. Important mammal species include white-tailed deer, raccoon, mink, badger, striped skunk, red fox, muskrat, and white-tailed jackrabbit. The average annual harvest of white-tailed deer is about 300 animals.

The county has five fishing lakes, but these are marginal fisheries at best. The potential for developing new fishing waters or for improving existing waters is poor.

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can

be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 9, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, oats, and barley.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are tall wheatgrass, bromegrass, sweetclover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness. surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are little bluestem, goldenrod, needlegrass, western wheatgrass, and blue grama.

Shrubs are bushy woody plants that produce fruit, buds, twigs, bark, and foliage. Soil properties and features that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and soil moisture. Examples of shrubs are chokecherry, hawthorn, snowberry, and woods rose.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, rivergrass, wild millet, inland saltgrass, cordgrass, bulrush, sedges, and mannagrass.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl-feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The wildlife attracted to these areas include gray partridge, pheasant, meadowlark, field sparrow, cottontail, and red fox.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, muskrat, mink, and beaver.

Habitat for rangeland wildlife consists of areas of shrubs and wild herbaceous plants. Wildlife attracted to rangeland include white-tailed deer, sharp-tailed grouse, meadowlark, horned lark, and lark bunting.

About 102,000 acres in Kidder County, or more than 11 percent of the total acreage, meets the requirements for hydric soils. The map units in the county that generally display hydric conditions are listed in this section. They are considered hydric soils unless they have been artificially drained or otherwise so altered that they no longer support a predominance of hydrophytic vegetation. The soil maps in this survey do not identify the drained areas. This list does not constitute a recommendation for a particular land use. The extent of each listed map unit is shown in table 4, and the location is shown on the detailed soil maps at the back of this publication. The soil qualities that affect use and management are described under the heading "Detailed Soil Map Units."

2 Arveson loam, wet
3 Marysland loam

5 Harriet silt loam
7 Arveson-Ulen complex, 0 to 3 percent slopes (Arveson part)
10 Minnewaukan and Stirum soils
14 Tonka loam
15 Parnell silty clay loam
16 Southam silty clay loam
17 Markey muck
19 Colvin silt loam, saline
20 Colvin silt loam
29E Barnes-Buse-Parnell complex, 0 to 35 percent slopes (Parnell part)

Engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil Properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 to 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of absorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

Building Site Development

Table 10 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, and local roads and streets. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock, a cemented pan, or a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

Dwellings and small commercial buildings are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for

dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock or to a cemented pan, large stones, slope, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 to 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock or to a cemented pan, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic supporting capacity.

Sanitary Facilities

Table 11 shows the degree and kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 11 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock or to a cemented pan, and flooding affect absorption of the effluent. Large stones and bedrock or a cemented pan interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to filter the effluent effectively. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 11 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock or to a cemented pan, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope, bedrock, and cemented pans can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 11 are based on soil properties, site features, and observed performance of the soils.

Permeability, depth to bedrock or to a cemented pan, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock, a cemented pan, or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

Construction Materials

Table 12 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a *probable* or *improbable* source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 12, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and

cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

Water Management

Table 13 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas and for embankments, dikes, and levees. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock, to a cemented pan, or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and potential frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock or to a cemented pan, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock or to a cemented pan. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to reduce erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock or to a cemented pan affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of soil blowing or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock or to a cemented pan affect the construction of grassed waterways. A hazard of soil blowing, low available water capacity, restricted rooting depth, toxic substances such as salts or sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

Soil Properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics. These results are reported in table 17.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classifications, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

Engineering Index Properties

Table 14 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil Series and Their Morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as about 15 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the Unified soil classification system (*2*) and the system adopted by the American Association of State Highway and Transportation Officials (*1*).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest. The AASHTO classification for soils tested, with group index numbers in parentheses, is given in table 17.

Rock fragments larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

The estimates of grain-size distribution, liquid limit, and plasticity index are generally rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount (1 or 2 percentage points) across classification boundaries, the classification in the marginal zone is omitted in the table.

Physical and Chemical Properties

Table 15 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Salinity is a measure of soluble salts in the soil at saturation. It is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at representative sites of nonirrigated soils. The salinity of irrigated soils is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of soils in individual fields can differ greatly from the value given in the table. Salinity affects the suitability of a soil for crop production, the stability of soil if used as construction material, and the potential of the soil to corrode metal and concrete.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to soil blowing in cultivated areas. The groups indicate the susceptibility to soil blowing. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.
2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible. Crops can be grown if intensive measures to control soil blowing are used.
3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly

erodible. Crops can be grown if intensive measures to control soil blowing are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible. Crops can be grown if intensive measures to control soil blowing are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control soil blowing are used.

5. Loamy soils that are less than 20 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible. Crops can be grown if measures to control soil blowing are used.

6. Loamy soils that are 20 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible. Crops can easily be grown.

7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible. Crops can easily be grown.

8. Stony or gravelly soils and other soils not subject to soil blowing.

Soil and Water Features

Table 16 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the intake of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to two hydrologic groups in table 16, the first letter is for drained areas and the second is for undrained areas.

Flooding, the temporary inundation of an area, is caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt is not considered flooding, nor is water in swamps and marshes.

Table 16 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *occasional* that it occurs, on the average, once or less in 2 years; and *frequent* that it occurs, on the average, more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 16 are the depth to the seasonal high water table; the kind of water table—that is, perched or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 16.

An *apparent* water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. A *perched*

water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Only saturated zones within a depth of about 6 feet are indicated. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured clayey soils that have a high water table in winter are the most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Engineering Index Test Data

Table 17 shows laboratory test data for several pedons sampled at carefully selected sites in the survey area. The pedons are representative of the series described in the section "Soil Series and Their Morphology." The soil samples were tested by the North Dakota State Highway Department.

The testing methods generally are those of the American Association of State Highway and Transportation Officials (AASHTO) or the American Society for Testing and Materials (ASTM).

The tests and methods are AASHTO classification—M 145 (AASHTO), D 3282 (ASTM); Unified classification—D 2487 (ASTM); Mechanical analysis—T 88 (AASHTO), D 2217 (ASTM); Liquid limit—T 89 (AASHTO), D 423 (ASTM); Plasticity index—T 90 (AASHTO), D 424 (ASTM); and Moisture density, Method A—T 99 (AASHTO), D 698 (ASTM).

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (*14*). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 18 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Mollisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Boroll (*Bor*, meaning cool, plus *oll*, from Mollisol).

GREAT GROUP Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Haploborolls (*Hapl*, meaning minimal horizonation, plus *boroll*, the suborder of the Mollisols that has a frigid temperature regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Udic* identifies the subgroup that is more moist than is typical for the great group. An example is Udic Haploborolls.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine-loamy, mixed Udic Haploborolls.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

Soil Series and Their Morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the *Soil Survey Manual* (*13*). Many of the technical terms used in the descriptions are defined in *Soil Taxonomy* (*14*). Unless otherwise stated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed Soil Map Units."

Arveson Series

The Arveson series consists of deep, poorly drained and very poorly drained, moderately rapidly permeable, highly calcareous soils on glacial outwash plains. These soils formed in loamy and sandy glacial outwash. Slope is 0 to 1 percent.

Typical pedon of Arveson loam, in an area of Arveson-Ulen complex, 0 to 3 percent slopes, 160 feet west and 370 feet north of the southeast corner of sec. 13, T. 138 N., R. 72 W.

A—0 to 6 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak fine granular structure; slightly

hard, friable, slightly sticky and slightly plastic; common fine and many very fine roots; strong effervescence; mildly alkaline; clear smooth boundary.

Ak—6 to 13 inches; very dark gray (10YR 3/1) loam, gray (10YR 5/1) dry; weak medium subangular blocky structure parting to moderate very fine and fine granular; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; disseminated lime throughout; violent effervescence; moderately alkaline; clear wavy boundary.

Bk—13 to 22 inches; grayish brown (2.5Y 5/2) fine sandy loam, light brownish gray (2.5Y 6/2) dry; few fine prominent dark yellowish brown (10YR 4/6) and light gray (10YR 7/2) mottles; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; disseminated lime throughout; violent effervescence; moderately alkaline; clear wavy boundary.

Bw—22 to 42 inches; grayish brown (2.5Y 5/2) loamy fine sand, light brownish gray (2.5Y 6/2) dry; few fine distinct olive brown (2.5Y 4/4) and few fine prominent yellowish brown (10YR 5/4) mottles; weak very fine granular structure; soft, very friable, nonsticky and nonplastic; few very fine roots; strong effervescence; moderately alkaline; gradual wavy boundary.

C—42 to 55 inches; light brownish gray (2.5Y 6/2) fine sand, light gray (2.5Y 7/2) dry; common medium prominent dark yellowish brown (10YR 4/6) and many medium prominent reddish brown (5YR 4/4) mottles; single grain; loose, nonsticky and nonplastic; disseminated lime throughout; slight effervescence; moderately alkaline; clear wavy boundary.

Cg—55 to 60 inches; olive gray (5Y 5/2) fine sand, light olive gray (5Y 6/2) dry; few fine prominent dark reddish brown (5YR 3/3) and few large prominent olive brown (2.5Y 4/4) mottles; single grain; loose, nonsticky and nonplastic; disseminated lime throughout; slight effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. The depth to loamy fine sand or coarser textures is 20 to 30 inches.

The A horizon has hue of 10YR or 2.5Y, value of 2 or 3, and chroma of 1. The Bk horizon has hue of 2.5Y or 5Y, value of 3 to 6, and chroma of 1 or 2. It is not mottled in some pedons. The C horizon has colors similar to those of the Bk horizon.

Arvilla Series

The Arvilla series consists of deep, somewhat excessively drained soils on glacial outwash plains. These soils formed in loamy and sandy glacial outwash. They are underlain by loamy sand at a depth of about 16 inches. Permeability is moderately rapid in the upper part of the profile and very rapid in the lower part. Slope ranges from 1 to 15 percent.

These soils have a slightly higher chroma in the surface layer than is definitive for the Arvilla series. This difference, however, does not alter the usefulness or behavior of the soils.

Typical pedon of Arvilla sandy loam, 1 to 6 percent slopes, 1,420 feet north and 1,000 feet east of the southwest corner of sec. 16, T. 139 N., R. 72 W.

Ap—0 to 8 inches; very dark brown (10YR 2/2) sandy loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; soft, friable, nonsticky and nonplastic; many fine roots; neutral; abrupt smooth boundary.

Bw1—8 to 16 inches; very dark grayish brown (10YR 3/2) sandy loam, dark grayish brown (10YR 4/2) dry; moderate coarse subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common fine roots; neutral; clear wavy boundary.

Bw2—16 to 22 inches; very dark grayish brown (10YR 3/2) loamy sand, grayish brown (10YR 5/2) dry; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; few fine roots; slight effervescence; mildly alkaline; clear smooth boundary.

2Bk—22 to 39 inches; dark grayish brown (2.5Y 4/2) coarse sand, light brownish gray (2.5Y 6/2) dry; single grain; loose, nonsticky and nonplastic; few fine roots; about 10 percent gravel; discontinuous layers of lime 0.5 inch to 2.0 inches thick; strong effervescence; mildly alkaline; clear wavy boundary.

2C—39 to 60 inches; grayish brown (2.5Y 5/2) coarse sand, light brownish gray (2.5Y 6/2) dry; single grain; loose, nonsticky and nonplastic; few fine roots; about 10 percent gravel; slight effervescence; mildly alkaline.

The depth to sand or gravel is 14 to 25 inches. The A horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1 or 2. The Bw horizon has hue of 10YR or 2.5Y, value of 2 to 4 (3 to 5 dry), and chroma of 1 to 3. The 2C horizon is sand, very gravelly coarse sand, coarse sand, or gravelly loamy sand. The gravel content in this horizon ranges from 5 to 55 percent.

Barnes Series

The Barnes series consists of deep, well drained, moderately slowly permeable soils on glacial till plains and moraines. These soils formed in loamy glacial till. Slope ranges from 1 to 25 percent.

Typical pedon of Barnes loam, in an area of Barnes-Svea loams, 1 to 6 percent slopes, 950 feet east and

200 feet south of the northwest corner of sec. 1, T. 144 N., R. 70 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak coarse subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; about 2 percent gravel; mildly alkaline; abrupt smooth boundary.

Bw1—8 to 13 inches; very dark brown (10YR 2/2) loam, dark grayish brown (10YR 4/2) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; about 2 percent gravel; mildly alkaline; clear smooth boundary.

Bw2—13 to 19 inches; dark grayish brown (10YR 4/2) loam, pale brown (10YR 6/3) dry; weak coarse subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; about 3 percent gravel; mildly alkaline; clear wavy boundary.

Bk—19 to 32 inches; light yellowish brown (2.5Y 6/4) loam, light gray (2.5Y 7/2) dry; many medium faint light yellowish brown (10YR 6/4) mottles; weak coarse subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; about 5 percent gravel; few irregular soft masses of lime; strong effervescence; moderately alkaline; gradual wavy boundary.

C—32 to 60 inches; dark grayish brown (2.5Y 4/2) clay loam, light brownish gray (2.5Y 6/2) dry; many large distinct light yellowish brown (10YR 6/4) mottles; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; about 5 percent gravel; few fine rounded soft masses of lime; slight effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. The A horizon has hue of 10YR and value of 2 or 3 (3 or 4 dry). It generally has chroma of 1, but it has chroma of 2 below the Ap horizon in some pedons. It is loam or sandy loam. The Bw horizon has hue of 10YR or 2.5Y, value of 2 to 4 (4 to 6 dry), and chroma of 1 to 4. The Bk horizon has hue of 2.5Y or 10YR, value of 4 to 6 (5 to 7 dry), and chroma of 2 to 4. The C horizon is loam or clay loam.

Bowbells Series

The Bowbells series consists of deep, moderately well drained, moderately slowly permeable soils on glacial till plains. These soils formed in loamy glacial till. Slope ranges from 1 to 6 percent.

These soils have a slightly lower chroma in the surface layer than is definitive for the Bowbells series. This difference, however, does not alter the usefulness or behavior of the soils.

Typical pedon of Bowbells loam, in an area of Williams-Bowbells loams, 1 to 3 percent slopes, 1,250 feet south and 360 feet east of the northwest corner of sec. 16, T. 140 N., R. 73 W.

Ap—0 to 7 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; moderate fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; many fine roots; about 2 percent gravel; neutral; abrupt smooth boundary.

A—7 to 13 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; moderate medium prismatic structure parting to moderate medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; many fine roots; about 3 percent gravel; neutral; clear wavy boundary.

Bt1—13 to 26 inches; very dark grayish brown (10YR 3/2) clay loam, dark grayish brown (10YR 4/2) dry; moderate medium prismatic structure parting to strong medium angular blocky; slightly hard, firm, slightly sticky and slightly plastic; many fine roots; common faint clay films on faces of peds; about 3 percent gravel; neutral; gradual wavy boundary.

Bt2—26 to 32 inches; very dark grayish brown (10YR 3/2) clay loam, grayish brown (10YR 5/2) dry; strong medium prismatic structure parting to strong medium angular blocky; hard, firm, slightly sticky and slightly plastic; few fine roots; few faint clay films on faces of peds; about 2 percent gravel; neutral; clear wavy boundary.

Bw—32 to 36 inches; very dark grayish brown (2.5Y 3/2) loam, dark grayish brown (2.5Y 4/2) dry; moderate medium prismatic structure parting to moderate medium angular blocky; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; about 3 percent gravel; mildly alkaline; clear smooth boundary.

Bk—36 to 49 inches; grayish brown (2.5Y 5/2) clay loam, light brownish gray (2.5Y 6/2) dry; massive; hard, firm, slightly sticky and slightly plastic; about 5 percent gravel; disseminated lime throughout; strong effervescence; moderately alkaline; clear wavy boundary

C—49 to 60 inches; dark grayish brown (2.5Y 4/2) clay loam, light brownish gray (2.5Y 6/2) dry; massive; hard, firm, slightly sticky and slightly plastic; about 5 percent gravel; strong effervescence; moderately alkaline.

The gravel content ranges from 2 to 15 percent throughout the profile. The thickness of the mollic epipedon ranges from 16 to 36 inches.

The A horizon has hue of 10YR, value of 2 or 3 (3 to 5 dry), and chroma of 1 or 2. The Bt horizon has hue of 10YR or 2.5Y, value of 2 to 4 (4 to 6 dry), and chroma of 2 or 3. The Bk horizon has hue of 2.5Y or 10YR, value of 3 to 5 (4 to 7 dry), and chroma of 2 to 4.

Buse Series

The Buse series consists of deep, well drained, moderately slowly permeable soils on glacial till plains. These soils formed in loamy glacial till. Slope ranges from 6 to 35 percent.

Typical pedon of Buse loam, in an area of Buse-Barnes loams, 9 to 35 percent slopes, 440 feet south and 780 feet west of the northeast corner of sec. 15, T. 143 N., R. 72 W.

A—0 to 7 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; about 3 percent gravel; neutral; clear smooth boundary.

Bk—7 to 18 inches; grayish brown (2.5Y 5/2) loam, light gray (2.5Y 7/2) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; about 8 percent gravel; common medium irregular soft masses of lime; violent effervescence; moderately alkaline; clear wavy boundary.

C—18 to 60 inches; light olive brown (2.5Y 5/4) clay loam, light gray (2.5Y 7/2) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; about 3 percent gravel; common fine irregular soft masses of lime; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 12 inches. The depth to carbonates ranges from 0 to 12 inches. A few cobblestones or stones are in some pedons.

The A horizon has hue of 10YR, value of 2 or 3 (3 to 5 dry), and chroma of 1. Some pedons have an AB horizon. The Bk horizon has hue of 10YR or 2.5Y, value of 4 to 6 (4 to 7 dry), and chroma of 2 to 4. The C horizon is clay loam or loam.

Colvin Series

The Colvin series consists of deep, poorly drained and very poorly drained, moderately slowly permeable, highly calcareous soils on glacial outwash plains and till plains. These soils formed in silty and loamy glacial outwash and till. Slope is 0 to 1 percent.

Typical pedon of Colvin silt loam, 1,750 feet north and 300 feet east of the southwest corner of sec. 33, T. 141 N., R. 71 W.

A—0 to 7 inches; very dark gray (10YR 3/1) silt loam, dark gray (10YR 4/1) dry; weak medium granular structure; soft, very friable, slightly sticky and slightly plastic; many very fine roots; violent effervescence; moderately alkaline; abrupt wavy boundary.

Bk1—7 to 27 inches; dark gray (10YR 4/1) silty clay loam, light gray (10YR 7/1) dry; weak fine subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; disseminated lime throughout; violent effervescence; moderately alkaline; clear smooth boundary.

Bk2—27 to 42 inches; gray (10YR 5/1) silty clay loam, light gray (10YR 7/1) dry; massive; hard, very friable, slightly sticky and slightly plastic; few very fine roots; disseminated lime throughout; violent effervescence; moderately alkaline; clear wavy boundary.

Cg—42 to 60 inches; dark olive gray (5Y 3/2) clay loam, light olive gray (5Y 6/2) dry; common fine prominent dark yellowish brown (10YR 3/4) mottles; massive; very hard, firm, sticky and plastic; violent effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 24 inches. The depth to the calcic horizon ranges from 5 to 16 inches.

The A horizon has hue of 10YR to 5Y, value of 2 or 3, and chroma of 1. Some pedons have an Ak or ABk horizon. The Bk horizon has hue of 10YR to 5Y, value of 3 to 6, and chroma of 2 or less. The Cg horizon has hue of 2.5Y or 5Y, value of 3 to 6, and chroma of 1 to 4. It is silty clay loam, clay loam, or silt loam. In some pedons loam or stratified sand is below a depth of 40 inches.

Cresbard Series

The Cresbard series consists of deep, moderately well drained, slowly permeable, alkali soils on glacial till plains. These soils formed in loamy glacial till. Slope ranges from 1 to 6 percent.

Typical pedon of Cresbard loam, in an area of Cresbard-Barnes loams, 1 to 6 percent slopes, 2,550 feet west and 675 feet north of the southeast corner of sec. 31, T. 141 N., R. 70 W.

A—0 to 5 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; neutral; abrupt smooth boundary

B/E—5 to 10 inches; black (10YR 2/1) clay loam (B), very dark gray (10YR 3/1) dry; very dark gray (10YR 3/1) silt coatings (E), gray (10YR 5/1) dry; weak medium prismatic structure parting to moderate fine subangular blocky; hard, firm, sticky and plastic; neutral; clear wavy boundary.

Bt—10 to 21 inches; black (10YR 2/1) clay, very dark gray (10YR 3/1) dry; moderate coarse prismatic structure parting to strong medium and fine angular blocky; extremely hard, very firm, very sticky and very plastic; many distinct clay films on faces of peds; neutral; clear smooth boundary.

Bk—21 to 29 inches; very dark gray (10YR 3/1) clay loam, dark gray (10YR 4/1) dry; moderate medium

prismatic structure parting to moderate medium subangular blocky; extremely hard, very firm, sticky and plastic; few salt crystals; few fine soft masses of lime; strong effervescence; moderately alkaline; clear smooth boundary.

Bky—29 to 60 inches; very dark grayish brown (2.5Y 3/2) clay loam, gray (10YR 5/1) dry; weak fine and very fine subangular blocky structure; very hard, firm, sticky and plastic; few medium masses of gypsum crystals; few fine soft masses of lime; moderately alkaline.

The A horizon is 5 to 12 inches thick. It has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1. Some pedons have an E horizon. The B/E horizon has hue of 10YR, value of 2 or 3 (4 or 5 dry), and chroma of 1 or 2. The Bt horizon has hue of 10YR or 2.5Y, value of 2 to 4 (3 to 5 dry), and chroma of 1 to 3. It is clay or clay loam. The Bk and Bky horizons have hue of 10YR or 2.5Y.

Divide Series

The Divide series consists of deep, somewhat poorly drained, highly calcareous soils on glacial outwash plains. These soils formed in loamy and sandy glacial outwash. They are underlain by gravelly sand at a depth of about 26 inches. Permeability is moderate in the upper part of the profile and rapid in the lower part. Slope ranges from 0 to 3 percent.

Typical pedon of Divide loam, 0 to 3 percent slopes, 2,475 feet south and 1,150 feet west of the northeast corner of sec. 27, T. 142 N., R. 74 W.

A—0 to 7 inches; very dark gray (10YR 3/1) loam, gray (10YR 5/1) dry; moderate fine granular structure; soft, very friable, slightly sticky and slightly plastic; many very fine roots; disseminated lime; strong effervescence; moderately alkaline; clear smooth boundary.

Bk—7 to 26 inches; dark gray (10YR 4/1) loam, light gray (10YR 6/1) dry; weak medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; common very fine roots; disseminated lime throughout; violent effervescence; moderately alkaline; abrupt wavy boundary.

2C1—26 to 42 inches; light olive brown (2.5Y 5/4) gravelly coarse sand, light yellowish brown (2.5Y 6/4) dry; single grain; loose, nonsticky and nonplastic; few very fine roots; about 30 percent gravel; disseminated lime; slight effervescence; moderately alkaline; gradual smooth boundary.

2C2—42 to 60 inches; olive brown (2.5Y 4/4) gravelly coarse sand, light olive brown (2.5Y 5/4) and light yellowish brown (2.5Y 6/4) dry; single grain; loose, nonsticky and nonplastic; about 30 percent gravel; disseminated lime; slight effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. The depth to sand and gravel ranges from 20 to 40 inches.

The A horizon has hue of 10YR, value of 2 or 3 (3 to 5 dry), and chroma of 1. The Bk horizon has hue of 10YR or 2.5Y, value of 3 to 6 (5 to 8 dry), and chroma of 1 to 3. It is loam or clay loam. The 2C horizon has hue of 10YR to 5Y, value of 4 to 6 (5 to 8 dry), and chroma of 3 to 6. The gravel content in this horizon ranges from 10 to 45 percent.

Embden Series

The Embden series consists of deep, moderately well drained soils on glacial outwash plains and on glacial till and lacustrine plains mantled by loamy and sandy material. These soils formed in loamy and sandy glacial outwash, glacial lacustrine material, and eolian sediments. Permeability either is moderately rapid throughout the profile or is moderately rapid in the upper part of the profile and moderately slow in the lower part. Slope ranges from 1 to 6 percent.

Typical pedon of Embden fine sandy loam, 1 to 3 percent slopes, 2,620 feet east and 590 feet north of the southwest corner of sec. 34, T. 138 N., R. 74 W.

Ap—0 to 7 inches; black (10YR 2/1) fine sandy loam, very dark gray (10YR 3/1) dry; weak fine granular structure; soft, very friable, nonsticky and nonplastic; few medium and many fine and very fine roots; neutral; abrupt smooth boundary.

A—7 to 11 inches; black (10YR 2/1) fine sandy loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure parting to weak medium and fine granular; soft, very friable, nonsticky and nonplastic; many fine and very fine roots; neutral; clear wavy boundary.

Bw—11 to 22 inches; black (10YR 2/1) fine sandy loam, very dark gray (10YR 3/1) dry; weak medium prismatic structure parting to moderate medium subangular blocky; slightly hard, friable, slightly sticky and nonplastic; common fine and many very fine roots; neutral; clear wavy boundary.

Bk1—22 to 29 inches; very dark grayish brown (10YR 3/2) fine sandy loam, grayish brown (10YR 5/2) dry; common fine prominent dark reddish brown (5YR 3/4) mottles; weak coarse prismatic structure parting to weak medium subangular blocky; soft, very friable, slightly sticky and nonplastic; common very fine roots; disseminated lime throughout; violent effervescence; moderately alkaline; clear wavy boundary.

Bk2—29 to 53 inches; brown (10YR 4/3) loamy fine sand, pale brown (10YR 6/3) dry; common fine prominent yellowish brown (10YR 5/6) mottles; massive; slightly hard, very friable, nonsticky and nonplastic; few very fine roots; disseminated lime

throughout; violent effervescence; moderately alkaline; gradual wavy boundary.

C—53 to 60 inches; brown (10YR 4/3) fine sand, brown (10YR 5/3) dry; single grain; loose, nonsticky and nonplastic; violent effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 16 to more than 40 inches. The depth to fine sand is more than 40 inches.

The A horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1. The Bw horizon has hue of 10YR or 2.5Y, value of 2 to 4 (3 to 5 dry), and chroma of 1 to 3. The Bk horizon has hue of 10YR or 2.5Y, value of 3 to 6 (5 to 8 dry), and chroma of 2 to 4. It is fine sandy loam, sandy loam, or loamy fine sand. The C horizon has hue of 2.5Y or 10YR, value of 4 to 6 (5 to 7 dry), and chroma of 4 or less. It ranges from loamy fine sand to silty clay loam below a depth of 40 inches.

Flaxton Series

The Flaxton series consists of deep, well drained soils on glacial till plains mantled with eolian material. These soils formed in loamy eolian sediments and in the underlying glacial till. Permeability is moderately rapid in the upper part of the profile and moderately slow in the lower part. Slope ranges from 1 to 9 percent.

These soils have a slightly lower chroma in the surface layer than is definitive for the Flaxton series. This difference, however, does not alter the usefulness or behavior of the soils.

Typical pedon of Flaxton fine sandy loam, in an area of Flaxton-Zahl complex, 6 to 12 percent slopes, 1,340 feet west and 1,440 feet south of the northeast corner of sec. 24, T. 137 N., R. 74 W.

Ap—0 to 6 inches; black (10YR 2/1) fine sandy loam, dark gray (10YR 4/1) dry; weak fine granular structure; slightly hard, very friable, nonsticky and nonplastic; many very fine roots; neutral; clear smooth boundary.

Bw—6 to 21 inches; very dark grayish brown (10YR 3/2) fine sandy loam, dark grayish brown (10YR 4/2) dry; moderate medium subangular blocky structure; very hard, very friable, nonsticky and nonplastic; many very fine roots; neutral; clear wavy boundary.

2Bt—21 to 27 inches; very dark grayish brown (10YR 3/2) sandy clay loam, dark grayish brown (10YR 4/2) dry; moderate coarse prismatic structure parting to moderate coarse subangular blocky; hard, friable, sticky and plastic; common very fine roots; common faint clay films on faces of peds; about 5 percent gravel; few fine segregations of lime; mildly alkaline; abrupt wavy boundary.

2Bk—27 to 46 inches; brown (10YR 5/3) clay loam, pale brown (10YR 6/3) dry; weak medium subangular blocky structure; slightly hard, friable, sticky and plastic; common very fine roots; about 10 percent gravel; many medium round soft masses of lime; violent effervescence; moderately alkaline; clear smooth boundary.

2C—46 to 60 inches; olive brown (2.5Y 4/4) loam, light yellowish brown (2.5Y 6/4) dry; few fine prominent dark reddish brown (5YR 3/2) mottles; massive; soft, friable, slightly sticky and slightly plastic; few very fine roots; about 5 percent gravel; strong effervescence; moderately alkaline.

The depth to clay loam or loam ranges from 20 to 40 inches. The thickness of the mollic epipedon ranges from 16 to 30 inches.

The A horizon has hue of 10YR, value of 2 or 3 (3 to 5 dry), and chroma of 1 to 3. The 2Bt horizon has hue of 10YR or 2.5Y, value of 3 or 4 (4 to 6 dry), and chroma of 2 to 4. The 2C horizon has hue of 10YR to 5Y, value of 4 to 6 (5 to 7 dry), and chroma of 2 to 4. It is clay loam or loam. The gravel content in this horizon is 2 to 10 percent.

Fordville Series

The Fordville series consists of deep, well drained soils on glacial outwash plains. These soils formed in loamy and sandy glacial outwash. They are underlain by gravelly sand at a depth of about 29 inches. Permeability is moderate in the upper part of the profile and rapid in the lower part. Slope ranges from 0 to 3 percent.

Typical pedon of Fordville loam, 0 to 3 percent slopes, 1,100 feet north and 900 feet east of the southwest corner of sec. 20, T. 142 N., R. 74 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak fine granular structure; soft, very friable, slightly sticky and slightly plastic; many very fine roots; about 2 percent gravel; neutral; abrupt smooth boundary.

Bw1—8 to 21 inches; very dark brown (10YR 2/2) loam, dark grayish brown (10YR 4/2) dry; weak medium prismatic structure parting to moderate medium subangular blocky; soft, friable, slightly sticky and slightly plastic; common very fine roots; about 4 percent gravel; neutral; clear smooth boundary.

Bw2—21 to 29 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; moderate medium subangular blocky structure; soft, friable, slightly sticky and slightly plastic; few fine roots; about 7 percent gravel; neutral; abrupt smooth boundary.

2Bk—29 to 33 inches; dark brown (10YR 3/3) gravelly sand, brown (10YR 5/3) dry; single grain; loose, nonsticky and nonplastic; few fine roots; about 30 percent gravel; disseminated lime throughout; slight effervescence; mildly alkaline; clear smooth boundary.

2C—33 to 60 inches; dark brown (10YR 3/3) gravelly sand, brown (10YR 5/3) dry; single grain; loose, nonsticky and nonplastic; few fine roots; about 15 percent gravel; mildly alkaline.

The thickness of the mollic epipedon ranges from 16 to 30 inches. The depth to sand and gravel ranges from 20 to 40 inches.

The A horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1. The Bw horizon has hue of 10YR or 2.5Y, value of 2 or 3 (3 to 5 dry), and chroma of 1 to 3. The 2C horizon has hue of 10YR or 2.5Y, value of 3 to 6 (5 to 7 dry), and chroma of 1 to 4. It is coarse sand, gravelly coarse sand, or gravelly sand. The gravel content in this horizon is 10 to 45 percent.

Hamerly Series

The Hamerly series consists of deep, somewhat poorly drained, moderately slowly permeable, highly calcareous soils on glacial till plains. These soils formed in loamy glacial till. Slope ranges from 0 to 3 percent.

Typical pedon of Hamerly loam, 0 to 3 percent slopes, 415 feet south and 2,010 feet west of the northeast corner of sec. 7, T. 142 N., R. 71 W.

Ap—0 to 7 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; many very fine roots; about 3 percent gravel; slight effervescence; moderately alkaline; abrupt smooth boundary.

Bk1—7 to 24 inches; light brownish gray (2.5Y 6/2) clay loam, light gray (2.5Y 7/2) dry; few fine prominent olive (5Y 4/4) and gray (5Y 5/1) mottles; weak coarse prismatic structure parting to moderate medium subangular blocky; hard, friable, slightly sticky and slightly plastic; common very fine roots; about 3 percent gravel; disseminated lime throughout; violent effervescence; moderately alkaline; clear wavy boundary.

Bk2—24 to 36 inches; olive (5Y 4/3) clay loam, light brownish gray (2.5Y 6/2) dry; few fine distinct gray (5Y 5/1) and few medium prominent dark yellowish brown (10YR 4/4) mottles; weak medium prismatic structure; hard, friable, slightly sticky and slightly plastic; few very fine roots; about 3 percent gravel; disseminated lime throughout; violent effervescence; moderately alkaline; gradual wavy boundary.

C—36 to 60 inches; olive (5Y 4/3) clay loam, light brownish gray (2.5Y 6/2) dry; common medium prominent strong brown (7.5YR 5/8), common fine prominent red (2.5YR 4/8), and common medium distinct gray (5Y 5/1) mottles; massive; hard, firm, slightly sticky and slightly plastic; about 3 percent gravel; strong effervescence; moderately alkaline.

The A horizon has hue of 10YR or 2.5Y, value of 2 or 3 (3 or 4 dry), and chroma of 1 or 2. In some pedons it does not have free carbonates. The Bk horizon has hue of 10YR to 5Y, value of 4 to 7 (5 to 8 dry), and chroma of 1 to 4. The C horizon has hue of 2.5Y or 5Y, value of 4 to 6 (5 to 7 dry), and chroma of 1 to 4. It is loam or clay loam.

Harriet Series

The Harriet series consists of deep, poorly drained, slowly permeable soils in drainageways and on the edges of lake plains. These soils formed in alluvium and lacustrine sediments. Slope is 0 to 1 percent.

Typical pedon of Harriet silt loam, 1,380 feet east and 2,600 feet south of the northwest corner of sec. 6, T. 137 N., R. 74 W.

E—0 to 1 inch; very dark gray (10YR 3/1) silt loam, gray (10YR 5/1) dry; moderate very thin platy structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; disseminated lime; slight effervescence; moderately alkaline; abrupt smooth boundary.

Bt—1 to 9 inches; very dark gray (10YR 3/1) clay loam, dark gray (10YR 4/1) dry; strong medium columnar structure; very hard, firm, sticky and plastic; common very fine roots; few faint clay films on faces of peds; disseminated lime throughout; slight effervescence; strongly alkaline; clear wavy boundary.

Czg—9 to 60 inches; olive gray (5Y 5/2) clay loam, light gray (5Y 6/1) dry; few fine faint mottles, light gray (5Y 7/2) dry; massive; very hard, friable, sticky and plastic; few fine roots; few fine salt crystals; disseminated lime throughout; strong effervescence; strongly alkaline.

Some pedons have an A horizon, which is 1 to 4 inches thick. The E horizon has hue of 10YR or 2.5Y, value of 2 or 3, and chroma of 1. The Bt horizon has hue of 10YR to 5Y, value of 2 to 4, and chroma of 1 or 2. It is clay loam or clay. The Czg horizon has hue of 10YR to 5Y, value of 3 to 5, and chroma of 1 to 3. It is clay loam, silty clay loam, or silty clay.

Hecla Series

The Hecla series consists of deep, moderately well drained, rapidly permeable soils on glacial outwash plains. These soils formed in sandy glacial outwash. Slope ranges from 1 to 6 percent.

Typical pedon of Hecla loamy fine sand, in an area of Hecla-Ulen loamy fine sands, 1 to 6 percent slopes, 2,500 feet east and 200 feet south of the northwest corner of sec. 8, T. 138 N., R. 71 W.

Ap—0 to 8 inches; black (10YR 2/1) loamy fine sand, very dark gray (10YR 3/1) dry; weak fine subangular

blocky structure; loose, nonsticky and nonplastic; many very fine roots; neutral; abrupt smooth boundary.

A—8 to 29 inches; very dark grayish brown (10YR 3/2) loamy sand, dark grayish brown (10YR 4/2) dry; weak medium subangular blocky structure; loose, nonsticky and nonplastic; common very fine roots; neutral; clear smooth boundary.

AC—29 to 41 inches; very dark grayish brown (10YR 3/2) loamy sand, grayish brown (10YR 5/2) dry; common fine faint dark yellowish brown (10YR 3/4) and few fine distinct light brownish gray (2.5Y 6/2) mottles; single grain; loose, nonsticky and nonplastic; common very fine roots; neutral; clear smooth boundary.

C1—41 to 54 inches; brown (10YR 4/3) loamy sand, pale brown (10YR 6/3) dry; common medium distinct yellowish brown (10YR 5/6) mottles; single grain; loose, nonsticky and nonplastic; common very fine roots; mildly alkaline; clear smooth boundary.

C2—54 to 60 inches; brown (10YR 5/3) loamy sand, pale brown (10YR 6/3) dry; single grain; loose, nonsticky and nonplastic; few very fine roots; mildly alkaline.

The depth to carbonates ranges from 20 to 60 inches. The A horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1 or 2. The AC horizon has hue of 10YR, value of 2 or 3 (3 to 5 dry), and chroma of 1 or 2. Some pedons do not have an AC horizon. The C horizon has hue of 10YR or 2.5Y, value of 3 to 5 (4 to 7 dry), and chroma of 2 to 4. It is loamy sand, fine sand, or sand.

Letcher Series

The Letcher series consists of deep, somewhat poorly drained, slowly permeable, alkali soils on glacial till plains and lacustrine plains. These soils formed in loamy and sandy sediments over clayey and silty lacustrine sediments or loamy glacial till. Slope ranges from 0 to 3 percent.

Typical pedon of Letcher fine sandy loam, 0 to 3 percent slopes, 260 feet west and 1,680 feet south of the northeast corner of sec. 36, T. 138 N., R. 74 W.

Ap—0 to 9 inches; black (10YR 2/1) fine sandy loam, very dark gray (10YR 4/1) dry; weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; few medium and many very fine roots; neutral; abrupt smooth boundary.

A—9 to 11 inches; black (10YR 2/1) fine sandy loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; neutral; clear smooth boundary.

E—11 to 13 inches; very dark gray (10YR 3/1) fine sandy loam, gray (10YR 5/1) dry; few fine prominent dark reddish brown (5YR 3/2) mottles; weak thin platy structure; soft, very friable, slightly sticky and slightly plastic; many very fine roots; neutral; clear wavy boundary.

Bt—13 to 16 inches; very dark grayish brown (10YR 3/2) fine sandy loam, dark grayish brown (10YR 4/2) dry; gray (10YR 5/1 dry) coatings on top of columns; strong coarse columnar structure; extremely hard, firm, slightly sticky and slightly plastic; common very fine roots along faces of peds; common faint clay films on faces of peds; strongly alkaline; clear wavy boundary.

Bk1—16 to 21 inches; dark brown (10YR 4/3) loamy sand, brown (10YR 5/3) dry; common medium prominent dark reddish brown (5YR 3/2) mottles; weak coarse prismatic structure parting to weak medium subangular blocky; slightly hard, friable, slightly sticky and nonplastic; few very fine roots; few salt crystals; disseminated lime throughout; violent effervescence; strongly alkaline; gradual wavy boundary.

Bk2—21 to 42 inches; light yellowish brown (2.5Y 6/4) fine sandy loam, light gray (2.5Y 7/2) dry; many medium prominent dark yellowish brown (10YR 3/4) mottles; weak medium subangular blocky structure; hard, very friable, slightly sticky and slightly plastic; few salt crystals; disseminated lime throughout; violent effervescence; strongly alkaline; gradual wavy boundary.

C—42 to 50 inches; dark grayish brown (2.5Y 4/2) sandy loam, light brownish gray (2.5Y 6/2) dry; many medium prominent dark reddish brown (5YR 3/4) mottles; massive; slightly hard, very friable, slightly sticky and slightly plastic; diffused lime throughout; strong effervescence; strongly alkaline; abrupt wavy boundary.

2Cg—50 to 60 inches; dark gray (5Y 4/1) silty clay, light gray (5Y 6/1) dry; common large prominent yellowish red (5YR 4/6) and common medium prominent yellowish red (5YR 5/8) mottles; massive; very hard, very firm, sticky and plastic; few fine rounded soft masses of lime; strong effervescence; strongly alkaline.

The A horizon is 5 to 15 inches thick. It has hue of 10YR, value of 2 or 3 (3 to 5 dry), and chroma of 1. The E horizon has hue of 10YR, value of 3 to 5 (5 to 7 dry), and chroma of 1 or 2. The Bt horizon has hue of 10YR or 2.5Y, value of 3 or 4 (4 to 6 dry), and chroma of 1 to 3. It is fine sandy loam or sandy loam. The Bk horizon has hue of 10YR or 2.5Y, value of 3 to 6 (4 to 7 dry), and chroma of 2 to 4. The C horizon is sandy loam or loamy sand. The 2C horizon is loam, clay loam, silty clay loam, or silty clay. Some pedons have an Ab horizon.

Maddock Series

The Maddock series consists of deep, well drained, rapidly permeable soils on glacial outwash plains and on glacial till plains mantled with eolian material. These soils formed in sandy glacial outwash and eolian sediments. Slope ranges from 1 to 9 percent.

Typical pedon of Maddock loamy fine sand, 1 to 6 percent slopes, 2,160 feet south and 580 feet east of the northwest corner of sec. 12, T. 139 N., R. 71 W.

Ap—0 to 5 inches; black (10YR 2/1) loamy fine sand, dark gray (10YR 4/1) dry; weak very fine granular structure; loose, nonsticky and nonplastic; many very fine roots; neutral; abrupt smooth boundary.

A—5 to 16 inches; very dark brown (10YR 2/2) loamy fine sand, dark grayish brown (10YR 4/2) dry; single grain; loose, nonsticky and nonplastic; common very fine roots; neutral; clear wavy boundary.

Bw—16 to 19 inches; dark brown (10YR 3/3) loamy fine sand, brown (10YR 5/3) dry; single grain; loose, nonsticky and nonplastic; common very fine roots; neutral; gradual wavy boundary.

C1—19 to 24 inches; brown (10YR 4/3) fine sand, pale brown (10YR 6/3) dry; single grain; loose, nonsticky and nonplastic; few very fine roots; mildly alkaline; gradual wavy boundary.

C2—24 to 60 inches; dark grayish brown (2.5Y 4/2) fine sand, light brownish gray (2.5Y 6/2) dry; single grain; loose, nonsticky and nonplastic; few very fine roots; disseminated lime; strong effervescence; mildly alkaline.

The thickness of mollic epipedon ranges from 10 to 16 inches. The gravel content throughout the profile ranges from 0 to 5 percent.

The Ap horizon has hue of 10YR, value of 2 or 3 (3 to 5 dry), and chroma of 1. The B horizon has hue of 10YR or 2.5Y, value of 2 to 5 (4 to 6 dry), and chroma of 2 to 4. It is loamy fine sand, loamy sand, or sand. The C horizon has hue of 10YR or 2.5Y, value of 3 to 6 (4 to 7 dry), and chroma of 2 to 4.

Markey Series

The Markey series consists of deep, very poorly drained, moderately rapidly permeable soils in glacial meltwater channels. These soils formed in organic and sandy material. Slope is 0 to 1 percent.

These soils contain more carbonates and receive less precipitation than is definitive for the Markey series. These differences, however, do not alter the usefulness or behavior of the soils.

Typical pedon of Markey muck, 420 feet north and 160 feet west of the southeast corner of sec. 4, T. 138 N., R. 72 W.

Oa1—0 to 5 inches; black (10YR 2/1) muck, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; many very fine roots; strong effervescence; clear smooth boundary.

Oe—5 to 8 inches; very dark grayish brown (10YR 3/2 broken face) peat, black (10YR 2/1) rubbed; about 55 percent fiber, 25 percent rubbed; weak medium subangular blocky structure; very friable; herbaceous fiber; slight effervescence; clear smooth boundary.

Oa2—8 to 28 inches; black (N 2/0 broken face and rubbed) muck; about 35 percent fiber, 15 percent rubbed; weak very thick platy structure; very friable; herbaceous fiber; slight effervescence; abrupt smooth boundary.

2Cg—28 to 60 inches; dark greenish gray (5GY 4/1) sand, greenish gray (5GY 6/1) dry; single grain; loose; about 2 percent gravel.

The depth to the 2Cg horizon ranges from 20 to 50 inches. This horizon has hue of 10YR to 5GY. It is sand or loamy sand.

Marysland Series

The Marysland series consists of deep, poorly drained, highly calcareous soils on glacial outwash plains. These soils formed in loamy and sandy glacial outwash. They are underlain by gravelly coarse sand at a depth of about 37 inches. Permeability is moderate in the upper part of the profile and rapid in the lower part. Slope is 0 to 1 percent.

These soils contain slightly less clay than is definitive for the Marysland series. This difference, however, does not alter the usefulness or behavior of the soils.

Typical pedon of Marysland loam, 235 feet west and 465 feet north of the southeast corner of sec. 33, T. 142 N., R. 74 W.

A1—0 to 4 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak fine granular structure; hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; slight effervescence; moderately alkaline; clear smooth boundary.

A2—4 to 7 inches; very dark gray (10YR 3/1) loam, gray (10YR 5/1) dry; moderate fine granular structure; hard, friable, slightly sticky and slightly plastic; many fine and very fine and few medium roots; slight effervescence; moderately alkaline; clear smooth boundary.

Bkg1—7 to 14 inches; dark gray (5Y 4/1) loam, light gray (5Y 6/1) dry; weak medium and coarse subangular blocky structure; hard, friable, slightly sticky and slightly plastic; many fine and very fine roots; disseminated lime throughout; violent effervescence; moderately alkaline; clear smooth boundary.

Bkg2—14 to 25 inches; dark gray (5Y 4/1) loam, gray (5Y 5/1) and light gray (5Y 6/1) dry; weak medium and coarse subangular blocky structure; hard, friable, slightly sticky and slightly plastic; common medium and fine roots; disseminated lime throughout; violent effervescence; moderately alkaline; clear smooth boundary.

2Cg1—25 to 37 inches; olive gray (5Y 5/2) gravelly coarse sandy loam, light olive gray (5Y 6/2) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; few fine and very fine roots; about 20 percent gravel; discontinuous layer of dark gray (5Y 4/1) loam; strong effervescence; moderately alkaline; abrupt wavy boundary.

2Cg2—37 to 45 inches; olive gray (5Y 5/2) gravelly coarse sand, light gray (5Y 7/2) dry; single grain; loose, nonsticky and nonplastic; few medium roots; about 20 percent gravel; slight effervescence; moderately alkaline; clear smooth boundary.

2Cg3—45 to 60 inches; olive gray (5Y 5/2) gravelly coarse sand, light gray (5Y 7/2) dry; single grain; loose, nonsticky and nonplastic; about 20 percent gravel; strong effervescence; moderately alkaline.

The depth to the Bkg horizon ranges from 6 to 16 inches. The depth to gravel and sand ranges from 20 to 40 inches.

The A horizon has hue of 10YR or 2.5Y, value of 2 or 3, and chroma of 1. The Bk horizon has hue of 2.5Y or 5Y, value of 3 to 6, and chroma of 2 or less. The gravel content in the 2C horizon is 10 to 70 percent.

Minnewaukan Series

The Minnewaukan series consists of deep, poorly drained, rapidly permeable soils on glacial outwash plains. These soils formed in loamy and sandy glacial outwash. Slope is 0 to 1 percent.

Typical pedon of Minnewaukan sandy loam, in an area of Minnewaukan and Stirum soils, 1,265 feet east and 135 feet north of the southwest corner of sec. 31, T. 144 N., R. 72 W.

A—0 to 3 inches; very dark grayish brown (2.5Y 3/2) sandy loam, grayish brown (2.5Y 5/2) dry; weak fine granular structure; soft, very friable, nonsticky and nonplastic; many very fine and many fine roots; strong effervescence; mildly alkaline; clear smooth boundary.

AC—3 to 8 inches; dark grayish brown (2.5Y 4/2) loamy fine sand, light brownish gray (2.5Y 6/2) dry; common medium distinct dark yellowish brown (10YR 4/6) and light olive brown (2.5Y 5/4) mottles; weak coarse subangular blocky structure; soft, very friable, nonsticky and nonplastic; many very fine roots; slight effervescence; mildly alkaline; clear wavy boundary.

Cg1—8 to 12 inches; olive (5Y 5/3) loamy fine sand, pale olive (5Y 6/3) dry; common medium distinct light olive brown (2.5Y 5/4) mottles; weak coarse prismatic structure; soft, very friable, nonsticky and nonplastic; common fine roots; slight effervescence; mildly alkaline; clear wavy boundary.

Cg2—12 to 24 inches; olive (5Y 5/3) fine sand, pale olive (5Y 6/3) dry; many large prominent yellowish brown (10YR 5/6) and gray (10YR 6/1) mottles; massive; loose, nonsticky and nonplastic; common medium and few fine roots; slight effervescence; moderately alkaline; clear irregular boundary.

Cg3—24 to 60 inches; olive gray (5Y 4/2) fine sand, light olive gray (5Y 6/2) dry; many large prominent dark gray (N 4/0) and strong brown (7.5YR 5/6) mottles; massive; loose, nonsticky and nonplastic; few medium roots; slight effervescence; moderately alkaline.

Some pedons have a thin O horizon. The A horizon has hue of 10YR or 2.5Y, value of 2 to 4, and chroma of 1 to 3. The C horizon has hue of 5GY to 10YR, value of 3 to 7, and chroma of 1 to 4. It is sand, fine sand, loamy fine sand, or loamy sand. Some pedons do not have mottles.

Miranda Series

The Miranda series consists of deep, moderately well drained, very slowly permeable, alkali soils on glacial till plains. These soils formed in loamy glacial till. Slope ranges from 0 to 6 percent.

Typical pedon of Miranda loam, 0 to 6 percent slopes, 1,700 feet south and 60 feet west of the northeast corner of sec. 36, T. 137 N., R. 74 W.

A—0 to 4 inches; black (10YR 2/1) loam, dark grayish brown (10YR 4/2) dry; weak thin platy structure parting to moderate fine granular; slightly hard, very friable, slightly sticky and slightly plastic; many very fine roots; about 2 percent gravel; neutral; clear wavy boundary.

E—4 to 7 inches; very dark gray (10YR 3/1) silt loam, dark gray (10YR 4/1) dry; moderate medium platy structure; soft, very friable, slightly sticky and slightly plastic; common very fine roots; few very dark grayish brown (10YR 3/2) coatings on faces of peds; about 2 percent gravel; neutral; abrupt wavy boundary.

Bt—7 to 12 inches; very dark grayish brown (10YR 3/2) clay loam, grayish brown (10YR 5/2) dry; strong fine columnar structure parting to strong fine and very fine angular blocky; very hard, firm, sticky and plastic; common very fine roots; many distinct clay films on faces of peds; few very dark gray (10YR 3/1) silt coatings on faces of peds; about 2 percent gravel; moderately alkaline; clear wavy boundary.

Bkyz—12 to 37 inches; olive brown (2.5Y 4/4) clay loam, light brownish gray (2.5Y 6/2) dry; massive; hard, very friable, sticky and plastic; few fine and very fine roots; about 2 percent gravel; common fine filaments and soft masses of gypsum and salts; disseminated lime throughout; strong effervescence; strongly alkaline; clear wavy boundary.

Bkyg—37 to 57 inches; olive gray (5Y 5/2) clay loam, light gray (5Y 7/2) dry; common medium prominent strong brown (7.5YR 4/6) mottles; massive; hard, very friable, sticky and plastic; few fine and very fine roots; many medium irregular filaments and soft masses of gypsum; common fine irregular soft masses of lime; strong effervescence; strongly alkaline; gradual wavy boundary.

Cg—57 to 60 inches; olive gray (5Y 5/2) clay loam, light gray (5Y 7/2) dry; common medium prominent strong brown (7.5YR 4/6) mottles; massive; hard, very friable, sticky and plastic; few very fine roots; disseminated lime; strong effervescence; strongly alkaline.

The depth to carbonates ranges from 6 to 18 inches. Some pedons have a salt crust at the surface.

The E horizon has hue of 10YR or 2.5Y, value of 3 to 5 (4 to 7 dry), and chroma of 1 or 2. The Bt horizon has hue of 10YR or 2.5Y, value of 2 to 5 (3 to 6 dry), and chroma of 1 to 3. The Bky horizon has hue of 10YR to 5Y, value of 4 to 6 (5 to 8 dry), and chroma of 1 to 4. It is clay loam or silty clay loam.

Noonan Series

The Noonan series consists of deep, moderately well drained, slowly permeable, alkali soils on glacial till plains. These soils formed in loamy glacial till. Slope ranges from 1 to 6 percent.

Typical pedon of Noonan loam, in an area of Williams-Noonan loams, 1 to 6 percent slopes, 2,275 feet north and 210 feet east of the southwest corner of sec. 31, T 140 N., R. 74 W.

Ap—0 to 8 inches; very dark brown (10YR 2/2) loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; about 5 percent gravel; neutral; abrupt smooth boundary.

E—8 to 11 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; moderate thin platy structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; about 5 percent gravel; neutral; abrupt smooth boundary.

Bt—11 to 18 inches; dark grayish brown (10YR 4/2) and brown (10YR 4/3) clay loam, grayish brown (10YR 5/2) and pale brown (10YR 6/3) dry; moderate medium and coarse columnar structure parting to moderate medium subangular blocky; very hard, firm, sticky and plastic; common very fine roots along faces of peds; many distinct very dark grayish brown (10YR 3/2) clay films on faces of peds; about 3 percent gravel; strongly alkaline; clear smooth boundary.

Bky—18 to 42 inches; dark grayish brown (2.5Y 4/2) clay loam, light brownish gray (2.5Y 6/2) dry; common medium distinct light olive brown (2.5Y 5/6) mottles; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; about 3 percent gravel; common medium irregularly shaped soft masses of gypsum and lime; violent effervescence; strongly alkaline; clear wavy boundary.

C—42 to 60 inches; dark grayish brown (2.5Y 4/2) clay loam, light brownish gray (2.5Y 6/2) dry; common medium distinct light olive brown (2.5Y 5/6) and few fine prominent reddish brown (5YR 4/4) mottles; massive; slightly hard, friable, slightly sticky and slightly plastic; about 3 percent gravel; few fine irregularly shaped soft masses of lime; strong effervescence; strongly alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. The A horizon has hue of 10YR, value of 2 or 3 (3 to 5 dry), and chroma of 2 or 3. The E horizon has hue of 10YR, value of 3 to 5 (5 to 7 dry), and chroma of 1 or 2. Some pedons do not have an E horizon. The Bt horizon has hue of 10YR or 2.5Y, value of 3 or 4 (5 or 6 dry), and chroma of 2 or 3. The Bky horizon has hue of 10YR to 5Y, value of 4 to 6 (5 to 7 dry), and chroma of 2 to 4.

Nutley Series

The Nutley series consists of deep, well drained, slowly permeable soils on glacial lake plains. These soils formed in clayey lacustrine sediments. Slope ranges from 1 to 6 percent.

Typical pedon of Nutley silty clay, 1 to 3 percent slopes, 1,980 feet east and 2,580 feet south of the northwest corner of sec. 11, T. 143 N., R. 70 W.

Ap—0 to 8 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; hard, firm, sticky and plastic; few fine roots; moderately alkaline; abrupt smooth boundary.

Bw1—8 to 19 inches; dark grayish brown (2.5Y 4/2) silty clay, light brownish gray (2.5Y 6/2) dry; moderate coarse prismatic structure parting to moderate medium subangular blocky; hard, firm, very sticky and very plastic; few very fine roots; common black (10YR 2/1) tongues 0.5 to 1.0 inch wide; slight effervescence; moderately alkaline; gradual wavy boundary.

Bw2—19 to 44 inches; dark grayish brown (2.5Y 4/2) silty clay, light brownish gray (2.5Y 6/2) dry; common fine faint light yellowish brown (2.5Y 6/4) mottles; weak coarse subangular blocky structure; hard, firm, very sticky and very plastic; few very fine roots; disseminated lime; strong effervescence; moderately alkaline; clear wavy boundary.
C—44 to 60 inches; dark grayish brown (2.5Y 4/2) silty clay, light brownish gray (2.5Y 6/2) dry; common medium prominent strong brown (7.5YR 5/6) mottles; massive; hard, firm, very sticky and very plastic; few irregularly shaped soft masses of lime; violent effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 8 to 16 inches. The A horizon has hue of 10YR or 2.5Y, value of 2 or 3 (3 or 4 dry), and chroma of 1. The Bw horizon has hue of 10YR or 2.5Y, value of 2 to 4 (3 to 6 dry), and chroma of 1 or 2. The C horizon has hue of 10YR to 5Y, value of 3 to 5 (5 to 7 dry), and chroma of 1 to 4.

Overly Series

The Overly series consists of deep, moderately well drained, moderately slowly permeable soils on glacial lake plains. These soils formed in silty lacustrine sediments. Slope ranges from 0 to 3 percent.

Typical pedon of Overly silt loam, 0 to 3 percent slopes, 1,250 feet east and 15 feet south of the northwest corner of sec. 20, T. 139 N., R. 73 W.

Ap—0 to 7 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; many very fine roots; neutral; gradual wavy boundary.
A—7 to 15 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many fine roots; neutral; clear wavy boundary.
Bw1—15 to 21 inches; very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate coarse prismatic structure parting to moderate medium subangular blocky; hard, friable, sticky and slightly plastic; common very fine roots; few thin clay films on faces of peds; mildly alkaline; gradual wavy boundary.
Bw2—21 to 28 inches; very dark grayish brown (2.5Y 3/2) silty clay loam, dark grayish brown (2.5Y 4/2) dry; moderate coarse prismatic structure parting to moderate medium subangular blocky; hard, firm, sticky and plastic; common very fine roots; few thin clay films on faces of peds; mildly alkaline; clear wavy boundary.
Bk1—28 to 35 inches; dark grayish brown (2.5Y 4/2) silty clay loam, light brownish gray (2.5Y 6/2) dry; weak coarse subangular blocky structure; hard, very firm, sticky and plastic; few very fine roots; few medium soft masses of lime; strong effervescence; moderately alkaline; gradual wavy boundary.
Bk2—35 to 50 inches; dark yellowish brown (10YR 4/4) silty clay loam, light yellowish brown (10YR 6/4) dry; weak coarse subangular blocky structure; hard, friable, sticky and plastic; few very fine roots; few medium soft masses of lime; strong effervescence; moderately alkaline; clear smooth boundary.
C—50 to 60 inches; olive brown (2.5Y 4/4) silty clay loam, light yellowish brown (2.5Y 6/4) dry; many fine distinct yellowish brown (10YR 5/6) mottles; massive; very hard, friable, sticky and plastic; slight effervescence; moderately alkaline.

The depth to carbonates ranges from 20 to 36 inches. The thickness of the mollic epipedon ranges from 16 to 30 inches.

The A horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1. The Bw horizon has hue of 10YR or 2.5Y, value of 2 to 4 (3 to 5 dry), and chroma of 1 to 4. The Bk horizon has hue of 10YR or 2.5Y, value of 4 to 6 (6 or 7 dry), and chroma of 2 to 4. The C horizon has hue of 2.5Y or 5Y.

Parnell Series

The Parnell series consists of deep, very poorly drained, slowly permeable soils on glacial till plains and moraines. These soils formed in clayey alluvium derived from glacial till. Slope is 0 to 1 percent.

Typical pedon of Parnell silty clay loam, 505 feet east and 260 feet south of the northwest corner of sec. 31, T. 144 N., R. 72 W.

A—0 to 7 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; hard, friable, slightly sticky and slightly plastic; many fine and very fine roots; neutral; gradual smooth boundary.
Bt1—7 to 18 inches; black (10YR 2/1) silty clay, dark gray (10YR 4/1) dry; weak coarse prismatic structure parting to moderate medium and coarse subangular blocky; very hard, friable, sticky and plastic; many fine and very fine roots; common faint clay films on faces of peds; slightly acid; gradual smooth boundary.
Bt2—18 to 29 inches; black (10YR 2/1) silty clay, dark gray (10YR 4/1) dry; weak very fine granular structure; very hard, friable, sticky and plastic; common fine and very fine roots; common distinct dark yellowish brown (10YR 4/4) clay films on faces of peds; few snail shells; few fine irregular soft filaments of gypsum; neutral; gradual smooth boundary.

Bt3—29 to 42 inches; very dark gray (10YR 3/1) silty clay, gray (10YR 5/1) dry; weak very fine granular structure; very hard, friable, sticky and plastic; few very fine roots; common faint clay films on faces of peds; few fine rounded masses of gypsum crystals; few fine rounded soft filaments of gypsum; neutral; gradual smooth boundary.

C—42 to 60 inches; very dark gray (10YR 3/1) silty clay, gray (10YR 5/1) dry; weak very fine granular structure; firm, sticky and plastic; few very fine roots; mildly alkaline.

The thickness of the solum ranges from 25 to more than 60 inches. The thickness of the mollic epipedon ranges from 30 to more than 60 inches.

Some pedons have an O horizon. The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1. The Bt horizon has hue of 10YR to 5Y, value of 2 to 4, and chroma of 1 or 2. It is silty clay, silty clay loam, or clay loam. The C horizon has hue of 10YR, 2.5Y, or 5Y, value of 3 to 5, and chroma of 1 or 2. It is silty clay, silty clay loam, or clay.

Renshaw Series

The Renshaw series consists of deep, somewhat excessively drained soils on glacial outwash plains. These soils are shallow to sand and gravel. They formed in loamy and sandy glacial outwash. Permeability is moderately rapid in the upper part of the profile and very rapid in the lower part. Slope ranges from 0 to 6 percent.

Typical pedon of Renshaw loam, 0 to 3 percent slopes, 2,200 feet east and 2,000 feet north of the southwest corner of sec. 30, T. 142 N., R. 74 W.

Ap—0 to 7 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak fine granular structure; soft, friable, slightly sticky and slightly plastic; common very fine roots; about 2 percent gravel; neutral; clear smooth boundary.

Bw—7 to 15 inches; very dark brown (10YR 2/2) loam, dark grayish brown (10YR 4/2) dry; weak medium prismatic structure parting to moderate medium subangular blocky; soft, friable, slightly sticky and slightly plastic; common very fine roots; about 2 percent gravel; neutral; clear wavy boundary.

2Bk—15 to 19 inches; dark brown (10YR 3/3) gravelly coarse sand, pale brown (10YR 6/3) dry; single grain; loose, nonsticky and nonplastic; many very fine roots; about 30 percent gravel; thin crusts of lime on undersides of pebbles and disseminated lime throughout; slight effervescence; mildly alkaline; clear irregular boundary.

2C—19 to 60 inches; dark brown (10YR 4/3) gravelly sand, pale brown (10YR 6/3) dry; single grain; loose, nonsticky and nonplastic; few very fine roots; about 20 percent gravel; slight effervescence; mildly alkaline.

The thickness of the mollic epipedon ranges from 6 to 16 inches. The depth to sand and gravel ranges from 14 to 22 inches.

The A horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1. The Bw horizon has hue of 10YR, value of 2 to 5 (3 to 6 dry), and chroma of 1 to 3. The 2C horizon has hue of 10YR or 2.5Y, value of 3 to 5 (4 to 6 dry), and chroma of 2 to 4. The gravel content in this horizon ranges from 10 to 60 percent.

Serden Series

The Serden series consists of deep, excessively drained, rapidly permeable soils on glacial outwash plains mantled with eolian material. These soils formed in sandy eolian sediments. Slope ranges from 3 to 35 percent.

Typical pedon of Serden loamy fine sand, 3 to 35 percent slopes, 330 feet west and 165 feet north of the southeast corner of sec. 18, T. 138 N., R. 71 W.

A—0 to 4 inches; very dark gray (10YR 3/1) loamy fine sand, dark gray (10YR 4/1) dry; weak medium granular structure; soft, very friable, nonsticky and nonplastic; few medium and many very fine and fine roots; neutral; clear smooth boundary.

AC—4 to 7 inches; very dark grayish brown (10YR 3/2) fine sand, grayish brown (10YR 5/2) dry; single grain; loose, nonsticky and nonplastic; common very fine roots; neutral; clear wavy boundary.

C—7 to 60 inches; dark grayish brown (2.5Y 4/2) fine sand, grayish brown (2.5Y 5/2) dry; single grain; loose, nonsticky and nonplastic; few very fine roots in the upper part; neutral.

The A horizon has hue of 10YR, value of 2 or 3 (3 to 5 dry), and chroma of 1. It ranges from 1 to 9 inches in thickness. Some pedons do not have an AC horizon. The C horizon has hue of 10YR or 2.5Y, value of 4 to 6 (5 to 7 dry), and chroma of 2 to 4.

Sioux Series

The Sioux series consists of deep, excessively drained, very rapidly permeable soils on glacial outwash plains. These soils formed in loamy and sandy glacial outwash. Slope ranges from 1 to 35 percent.

Typical pedon of Sioux loam, in an area of Renshaw-Sioux loams, 1 to 6 percent slopes, 800 feet north and 280 feet west of the southeast corner of sec. 9, T. 140 N., R. 71 W.

Ap—0 to 7 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine roots; about 5 percent gravel; mildly alkaline; clear smooth boundary.

AC—7 to 12 inches; dark grayish brown (10YR 4/2) sandy loam, grayish brown (10YR 5/2) dry; weak very fine subangular blocky structure; loose, nonsticky and nonplastic; common very fine roots; about 10 percent gravel; disseminated lime; strong effervescence; moderately alkaline; clear smooth boundary.

C—12 to 60 inches; dark brown (10YR 4/3) very gravelly sand, pale brown (10YR 6/3) dry; single grain; loose, nonsticky and nonplastic; few very fine roots in the upper part; about 55 percent gravel; lime coatings on the lower sides and bottoms of pebbles in the upper few inches and disseminated lime in the lower part; strong effervescence; moderately alkaline.

The depth to sand and gravel ranges from 6 to 14 inches. The thickness of the mollic epipedon ranges from 7 to 12 inches.

The A horizon has hue of 10YR, value of 2 or 3 (3 to 5 dry), and chroma of 1. It is sandy loam or loam. The C horizon has hue of 10YR or 2.5Y, value of 4 to 7 (5 to 8 dry), and chroma of 2 to 4. The gravel content in this horizon ranges from 35 to 60 percent.

Southam Series

The Southam series consists of deep, very poorly drained, slowly permeable soils on glacial till plains. These soils formed in silty and loamy alluvium derived from glacial till. Slope is 0 to 1 percent.

These soils have slightly more sand and less clay than is definitive for the Southam series. This difference, however, does not alter the usefulness or behavior of the soils.

Typical pedon of Southam silty clay loam, 1,175 feet north and 225 feet east of the southwest corner of sec. 25, T. 144 N., R. 73 W.

A—0 to 7 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; hard, friable, slightly sticky and slightly plastic; many fine roots; few snail shell fragments; disseminated lime throughout; slight effervescence; neutral; clear smooth boundary.

Ag1—7 to 18 inches; black (5Y 2/1) silty clay loam, dark gray (5Y 4/1) dry; hard, friable, slightly sticky and slightly plastic; weak medium prismatic structure parting to weak medium subangular blocky; common fine roots; common fine pores; common snail shell fragments; disseminated lime throughout; slight effervescence; neutral; clear wavy boundary.

Ag2—18 to 28 inches; black (5Y 2/1) clay loam, gray (5Y 5/1) dry; weak very fine subangular blocky structure; hard, friable, slightly sticky and plastic; few fine roots; few fine pores; few pebbles; common snail shell fragments; disseminated lime throughout; strong effervescence; neutral; gradual wavy boundary.

Cg1—28 to 38 inches; very dark gray (5Y 3/1) loam, gray (5Y 5/1) dry; weak very fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; few fine pores; few pebbles; few snail shell fragments; disseminated lime throughout; strong effervescence; mildly alkaline; gradual wavy boundary.

Cg2—38 to 60 inches; very dark gray (5Y 3/1) clay loam, light gray (5Y 6/1) dry; massive; hard, friable, slightly sticky and plastic; few fine roots; common fine pores; few pebbles; few snail shall fragments; disseminated lime throughout; strong effervescence; mildly alkaline.

The depth to carbonates ranges from 0 to 10 inches. Some pedons have an O horizon, which is as much as 6 inches thick.

The A horizon has hue of 10YR, 2.5Y, or 5Y or is neutral in hue. It has value of 2 or 3 and chroma of 0 to 2. The C horizon has hue of 2.5Y, 5Y, or 5GY or is neutral in hue. It has value of 3 to 7 and chroma of 0 to 2. It is mottled in some pedons. Some pedons have a 2C horizon.

Stirum Series

The Stirum series consists of deep, poorly drained, alkali soils on glacial outwash plains. These soils formed in sandy and loamy glacial outwash. Permeability is moderately slow in the upper part of the profile and rapid in the lower part. Slope is 0 to 1 percent.

Typical pedon of Stirum loamy sand, in an area of Minnewaukan and Stirum soils, 150 feet west and 450 feet north of the southeast corner of sec. 36, T. 138 N., R. 74 W.

A—0 to 3 inches; black (10YR 2/1) loamy sand, very dark gray (10YR 3/1) dry; single grain; loose, nonsticky and nonplastic; many very fine, many fine, and few coarse roots; moderately alkaline; abrupt smooth boundary.

Bt—3 to 10 inches; very dark grayish brown (10YR 3/2) sandy loam, gray (10YR 6/1) dry; strong very coarse prismatic structure parting to moderate medium subangular blocky; very hard, friable, sticky and plastic; many distinct clay films on faces of peds and in pores; common very fine and few fine roots; strong effervescence; moderately alkaline; clear wavy boundary.

Btg—10 to 13 inches; gray (5Y 6/1) sandy loam, light gray (5Y 7/1) dry; weak very coarse prismatic structure parting to weak fine and medium subangular blocky; hard, friable, slightly sticky and nonplastic; common very fine and few fine roots; very few faint clay films on faces of peds; dark

grayish brown (2.5Y 4/2) coatings on faces of peds; strong effervescence; moderately alkaline; clear wavy boundary.

Bg—13 to 20 inches; gray (5Y 6/1) sandy loam, light gray (5Y 7/1) dry; many medium faint olive gray (5Y 5/2) mottles; weak medium prismatic structure parting to weak fine subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; common very fine and few fine roots; slight effervescence; moderately alkaline; gradual wavy boundary.

Cg1—20 to 27 inches; light gray (5Y 7/2) loamy sand, white (5Y 8/2) dry; many medium distinct pale olive (5Y 6/3) mottles; massive; loose, nonsticky and nonplastic; common very fine and few fine roots; slight effervescence; moderately alkaline; gradual wavy boundary.

Cg2—27 to 36 inches; olive (5Y 5/4) loamy sand, pale yellow (5Y 7/3) dry; many medium light greenish gray (5GY 7/1) mottles; massive; loose, nonsticky and nonplastic; few very fine roots; slight effervescence; moderately alkaline; gradual wavy boundary.

Cg3—36 to 60 inches; olive gray (5Y 5/2) loamy sand, light olive gray (5Y 6/2) dry; many medium prominent greenish gray (5GY 6/1) and many medium distinct pale olive (5Y 6/3) mottles; single grain; loose, nonsticky and nonplastic; slight effervescence; moderately alkaline.

The thickness of the solum ranges from 13 to 30 inches. The depth to free carbonates is 0 to 3 inches.

The A horizon has hue of 10YR to 5Y, value of 2 or 3, and chroma of 2 or less. Some pedons have an E horizon. The Bt horizon has hue of 10YR to 5Y, value of 2 to 6, and chroma of 2 or less. It is sandy loam or loam. Some pedons have a Bk or BC horizon. The C horizon is loamy sand or sandy loam.

Svea Series

The Svea series consists of deep, moderately well drained, moderately slowly permeable soils on glacial till plains. These soils formed in loamy glacial till. Slope ranges from 1 to 6 percent.

Typical pedon of Svea loam, in an area of Buse-Svea loams, 3 to 15 percent slopes, 1,200 feet north and 2,300 feet east of the southwest corner of sec. 25, T. 143 N., R. 70 W.

A—0 to 7 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; moderate fine subangular blocky structure; soft, friable, slightly sticky and slightly plastic; many very fine roots; about 2 percent gravel; neutral; gradual smooth boundary.

Bw1—7 to 15 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; moderate medium prismatic structure parting to moderate medium subangular blocky; slightly hard, firm, slightly sticky and slightly plastic; many very fine roots; about 2 percent gravel; neutral; gradual wavy boundary.

Bw2—15 to 23 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak coarse prismatic structure parting to moderate fine subangular blocky; slightly hard, firm, slightly sticky and slightly plastic; common very fine roots; about 2 percent gravel; slight effervescence; mildly alkaline; abrupt wavy boundary.

Bk1—23 to 33 inches; dark grayish brown (2.5Y 4/2) clay loam, grayish brown (2.5Y 5/2) dry; common fine prominent yellowish brown (10YR 5/6) mottles; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; about 4 percent gravel; many large irregularly shaped soft masses of lime; violent effervescence; moderately alkaline; gradual wavy boundary.

Bk2—33 to 43 inches; dark grayish brown (2.5Y 4/2) clay loam, light brownish gray (2.5Y 6/2) dry; common fine prominent yellowish brown (10YR 5/6) mottles; massive; hard, friable, slightly sticky and slightly plastic; few very fine roots; about 3 percent gravel; common medium irregularly shaped soft masses of lime; violent effervescence; moderately alkaline; gradual wavy boundary.

C—43 to 60 inches; olive brown (2.5Y 4/4) clay loam, light yellowish brown (2.5Y 6/4) dry; common medium prominent yellowish brown (10YR 5/6) mottles; massive; hard, friable, slightly sticky and slightly plastic; about 4 percent gravel; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 16 to more than 30 inches. The gravel content ranges from 2 to 10 percent throughout the profile.

The A horizon has hue of 10YR, value of 2 or 3 (3 to 5 dry), and chroma of 1. The Bw horizon has hue of 10YR or 2.5Y, value of 2 to 4 (3 to 5 dry), and chroma of 1 to 3. The Bk horizon has hue of 2.5Y or 10YR, value of 4 to 6 (5 to 8 dry), and chroma of 1 to 4. The C horizon is loam or clay loam.

Tonka Series

The Tonka series consists of deep, poorly drained, slowly permeable soils on glacial till plains. These soils formed in loamy and silty alluvium derived from glacial till. Slope is 0 to 1 percent.

Typical pedon of Tonka loam, 850 feet west and 465 feet south of the northeast corner of sec. 13, T. 140 N., R. 74 W.

A—0 to 8 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure; soft, friable, slightly sticky and

slightly plastic; many very fine roots; slightly acid; clear smooth boundary.

E—8 to 16 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; common medium distinct brown (10YR 4/3) mottles; moderate medium platy structure; soft, friable, slightly sticky and slightly plastic; common very fine roots; medium acid; gradual smooth boundary.

Bt1—16 to 25 inches; very dark grayish brown (10YR 3/2) clay loam, grayish brown (10YR 5/2) dry; common medium distinct brown (10YR 4/3) mottles; light brownish gray (2.5Y 6/2) coatings on faces of peds; weak medium prismatic structure parting to strong very fine subangular blocky; slightly hard, firm, sticky and plastic; few fine roots; many distinct clay films on faces of peds; medium acid; gradual wavy boundary.

Bt2—25 to 43 inches; very dark grayish brown (10YR 3/2) silty clay loam, grayish brown (10YR 5/2) dry; moderate very fine subangular blocky structure; very hard, very firm, very sticky and very plastic; few fine roots; many distinct clay films on faces of peds; medium acid; clear wavy boundary.

BC—43 to 53 inches; grayish brown (2.5Y 5/2) silty clay loam, light brownish gray (2.5Y 6/2) dry; common medium distinct brown (10YR 4/3) mottles; massive; hard, firm, sticky and plastic; about 2 percent gravel; neutral; clear wavy boundary.

Cg—53 to 60 inches; olive gray (5Y 5/2) clay loam, light olive gray (5Y 6/2) dry; common medium prominent dark yellowish brown (10YR 4/4) mottles; massive; hard, firm, sticky and plastic; about 3 percent gravel; mildly alkaline.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1. The E horizon has hue of 10YR or 2.5Y, value of 3 to 5, and chroma of 2 or less. It is silt loam or loam. The Bt horizon has hue of 10YR to 5Y, value of 2 to 5, and chroma of 1 or 2. The Bt and C horizons are silty clay loam, clay loam, or silty clay.

Towner Series

The Towner series consists of deep, moderately well drained soils on glacial till plains mantled with eolian material. These soils formed in sandy eolian sediments and loamy glacial till. Permeability is rapid in the upper part of the profile and moderately slow in the lower part. Slope ranges from 1 to 9 percent.

Typical pedon of Towner loamy fine sand, in an area of Towner-Embden, loamy substratum complex, 1 to 6 percent slopes, 2,200 feet south and 575 feet east of the northwest corner of sec. 31, T. 138 N., R. 72 W.

A—0 to 18 inches; black (10YR 2/1) loamy fine sand, dark gray (10YR 4/1) dry; weak fine granular structure; soft, very friable, nonsticky and nonplastic; many very fine roots; neutral; gradual wavy boundary.

Bw—18 to 33 inches; very dark grayish brown (10YR 3/2) loamy sand, grayish brown (10YR 5/2) dry; weak coarse prismatic structure; soft, very friable, nonsticky and nonplastic; common very fine roots; mildly alkaline; clear wavy boundary.

2C1—33 to 41 inches; dark grayish brown (2.5Y 4/2) clay loam, light brownish gray (2.5Y 6/2) dry; common fine prominent dark yellowish brown (10YR 4/6) mottles; massive; hard, firm, slightly sticky and slightly plastic; few very fine roots; strong effervescence; moderately alkaline; gradual wavy boundary.

2C2—41 to 60 inches; grayish brown (2.5Y 5/2) loam, light gray (2.5Y 7/2) dry; common fine prominent dark yellowish brown (10YR 4/6) mottles; massive; hard, friable, slightly sticky and slightly plastic; few very fine roots; violent effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 16 to more than 30 inches. The depth to the 2C horizon ranges from 20 to 40 inches.

The A horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1. The Bw horizon has hue of 10YR or 2.5Y, value of 2 to 4 (3 to 6 dry), and chroma of 2 or 3. Some pedons have a 2Bk horizon. The 2C horizon has hue of 2.5Y or 5Y, value of 4 to 6 (6 to 8 dry), and chroma of 2 to 4. It is typically clay loam or loam, but in some pedons it is silt loam or silty clay loam.

Ulen Series

The Ulen series consists of deep, somewhat poorly drained, rapidly permeable, highly calcareous soils on glacial outwash plains. These soils formed in sandy outwash sediments. Slope ranges from 0 to 3 percent.

Typical pedon of Ulen loamy fine sand, in an area of Hecla-Ulen loamy fine sands, 1 to 6 percent slopes, 615 feet north and 2,500 feet east of the southwest corner of sec. 9, T. 139 N., R. 71 W.

Ap—0 to 7 inches; black (10YR 2/1) loamy fine sand, dark gray (10YR 4/1) dry; weak fine and medium granular and subangular blocky structure; soft, very friable, nonsticky and nonplastic; many very fine and common fine roots; slight effervescence; moderately alkaline; abrupt smooth boundary.

Ak—7 to 12 inches; very dark gray (10YR 3/1) loamy fine sand, dark gray (10YR 4/1) dry; weak medium and coarse subangular blocky structure; soft, very friable, nonsticky and nonplastic; few fine and common very fine roots; disseminated lime throughout; violent effervescence; moderately alkaline; clear wavy boundary.

Bk—12 to 24 inches; dark gray (10YR 4/1) loamy fine sand, gray (10YR 6/1) dry; weak medium and coarse subangular blocky structure; soft, very friable, nonsticky and nonplastic; few very fine roots; disseminated lime throughout; violent effervescence; moderately alkaline; clear smooth boundary.

Bkg—24 to 38 inches; olive (5Y 5/3) fine sand, pale olive (5Y 6/3) dry; weak medium subangular blocky structure; loose, nonsticky and nonplastic; few very fine roots; disseminated lime throughout; violent effervescence; moderately alkaline; gradual wavy boundary.

Cg—38 to 60 inches; olive (5Y 5/3) fine sand, pale olive (5Y 6/3) dry; few fine prominent yellowish red (5YR 4/6) and common fine and medium prominent yellow (10YR 7/6) mottles; single grain; loose, nonsticky and nonplastic; slight effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 10 to 20 inches. The A horizon has hue of 10YR, value of 2 or 3 (4 to 6 dry), and chroma of 1 or 2. The Bk horizon has hue of 10YR, value of 4 or 5 (6 or 7 dry), and chroma of 1 to 3. It is loamy sand, fine sand, or sandy loam. The C horizon has hue of 2.5Y or 5Y, value of 4 to 6 (6 to 8 dry), and chroma of 2 to 4.

Vebar Series

The Vebar series consists of moderately deep, well drained, moderately rapidly permeable soils on uplands. These soils formed in loamy and sandy material weathered from soft sandstone. Slope ranges from 9 to 35 percent.

Typical pedon of Vebar fine sandy loam, in an area of Vebar-Williams complex, 9 to 35 percent slopes, 600 feet south and 950 feet west of the northeast corner of sec. 36, T. 141 N., R. 73 W.

A—0 to 5 inches; very dark grayish brown (10YR 3/2) fine sandy loam, dark grayish brown (10YR 4/2) dry; moderate fine subangular blocky structure; slightly hard, very friable, slightly sticky and nonplastic; many fine and medium roots; slightly acid; gradual wavy boundary.

Bw1—5 to 9 inches; very dark grayish brown (10YR 3/2) fine sandy loam, dark grayish brown (10YR 4/2) dry; moderate medium prismatic structure parting to moderate medium subangular blocky; slightly hard, very friable, slightly sticky and nonplastic; many fine and medium roots; slightly acid; gradual wavy boundary.

Bw2—9 to 15 inches; dark grayish brown (10YR 4/2) fine sandy loam, grayish brown (10YR 5/2) dry; moderate medium prismatic structure parting to moderate medium subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; common fine and medium roots; neutral; gradual wavy boundary.

Bk—15 to 20 inches; dark grayish brown (2.5Y 4/2) fine sandy loam, light brownish gray (2.5Y 6/2) dry; weak medium prismatic structure parting to weak fine and medium subangular blocky; slightly hard, very friable, nonsticky and nonplastic; few fine roots; disseminated lime throughout; violent effervescence; moderately alkaline; gradual irregular boundary.

C—20 to 31 inches; dark grayish brown (2.5Y 4/2) loamy fine sand, light brownish gray (2.5Y 6/2) dry; massive; soft, very friable, nonsticky and nonplastic; few fine roots; strong effervescence; moderately alkaline; clear wavy boundary.

Cr—31 to 60 inches; dark grayish brown (2.5Y 4/2) soft sandstone; strong effervescence.

The depth to sandstone ranges from 20 to 40 inches. The thickness of the mollic epipedon ranges from 7 to 16 inches.

The A horizon has hue of 10YR, value of 2 or 3 (3 to 5 dry), and chroma of 2 or 3. The Bw horizon has hue of 10YR or 2.5Y, value of 3 or 4 (4 to 6 dry), and chroma of 2 to 4. The C horizon has hue of 10YR or 2.5Y, value of 4 to 6 (5 to 7 dry), and chroma of 2 to 4. It is loamy fine sand or fine sandy loam.

Williams Series

The Williams series consists of deep, well drained, moderately slowly permeable soils on glacial till plains and moraines. These soils formed in loamy glacial till. Slope ranges from 1 to 25 percent.

Typical pedon of Williams loam, in an area of Williams-Bowbells loams, 1 to 3 percent slopes, 80 feet north and 2,375 feet west of the southeast corner of sec. 4, T. 139 N., R. 74 W.

A—0 to 7 inches; very dark brown (10YR 2/2) loam, dark grayish brown (10YR 4/2) dry; moderate medium subangular blocky structure; soft, friable, slightly sticky and slightly plastic; many very fine roots; about 2 percent gravel; neutral; clear smooth boundary.

Bt—7 to 14 inches; dark grayish brown (2.5Y 4/2) clay loam, grayish brown (2.5Y 5/2) dry; moderate medium prismatic structure parting to strong medium subangular blocky; hard, friable, slightly sticky and slightly plastic; many very fine roots; common distinct very dark grayish brown (10YR 3/2) clay films on faces of peds; about 2 percent gravel; mildly alkaline; clear wavy boundary.

Bk—14 to 27 inches; light olive brown (2.5Y 5/4) clay loam, light brownish gray (2.5Y 6/2) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; about 2 percent gravel; many medium irregularly shaped soft masses

and fine threads of lime; violent effervescence; moderately alkaline; clear smooth boundary.

C—27 to 60 inches; grayish brown (2.5Y 5/2) clay loam, light brownish gray (2.5Y 6/2) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; about 2 percent gravel; few medium nests of gypsum; disseminated lime; strong effervescence; moderately alkaline.

The depth to free carbonates ranges from 10 to 30 inches. The gravel content throughout the profile ranges from 2 to 10 percent. The thickness of the mollic epipedon ranges from 7 to 15 inches.

The A horizon has hue of 10YR, value of 2 or 3 (3 to 5 dry), and chroma of 2. The Bt horizon has hue of 10YR or 2.5Y, value of 2 to 5 (4 to 6 dry), and chroma of 2 or 3. It is clay loam or loam. The Bk and C horizons have hue of 10YR to 5Y, value of 3 to 6 (5 to 8 dry), and chroma of 2 to 4.

Zahl Series

The Zahl series consists of deep, well drained, moderately slowly permeable soils on glacial till plains and moraines. These soils formed in loamy glacial till. Slope ranges from 6 to 35 percent.

Typical pedon of Zahl loam, in an area of Williams-Zahl loams, 9 to 35 percent slopes, 2,085 feet south and 35 feet west of the northeast corner of sec. 16, T. 140 N., R. 74 W.

A—0 to 6 inches; very dark brown (10YR 2/2) loam, dark grayish brown (10YR 4/2) dry; weak medium subangular blocky structure; soft, friable, slightly sticky and slightly plastic; many fine roots; about 3 percent gravel; mildly alkaline; abrupt wavy boundary.

Bk—6 to 26 inches; dark grayish brown (2.5Y 4/2) clay loam, light brownish gray (2.5Y 6/2) dry; few fine prominent reddish yellow (7.5YR 7/6) mottles; moderate coarse subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; about 5 percent gravel; many large rounded soft masses of lime; strong effervescence; moderately alkaline; gradual wavy boundary.

C—26 to 60 inches; dark grayish brown (2.5Y 4/2) clay loam, light brownish gray (2.5Y 6/2) dry; few medium prominent yellowish red (5YR 4/6) mottles; massive; slightly hard, friable, slightly sticky and slightly plastic; few fine roots in the upper part; about 5 percent gravel; slight effervescence; moderately alkaline.

The depth to carbonates ranges from 0 to 8 inches. The gravel content throughout the profile ranges from 2 to 15 percent.

The A horizon has hue of 10YR, value of 2 or 3 (3 to 5 dry), and chroma of 2. The Bk horizon has hue of 10YR to 5Y, value of 4 to 6 (5 to 8 dry), and chroma of 2 to 4. The C horizon has hue of 2.5Y or 5Y, value of 4 to 6 (5 to 8 dry), and chroma of 2 to 4. The Bk and C horizons are loam or clay loam.

Formation of the Soils

This section describes the major factors that affect soil formation. The characteristics of the soil at any given point are determined by the physical and mineralogical composition of the parent material, the climate that has affected the parent material, the plant and animal life on and in the soil, relief, and the length of time that the processes of soil formation have been active. The major processes are additions, removals, transfers, and transformations. Climate and plant and animal life help to determine the rate and nature of the weathering that over time changes the parent material into a natural body that has genetic horizons. The effects of climate and plant and animal life are modified by relief.

Parent Material

The accumulation of parent material is the first step in the formation of a soil. Most of the soils in Kidder County formed in material that was transported from the site of the parent rock and deposited at a new location by ice, water, wind, gravity, or a combination of these. The principal parent materials in the county are glacial till and glacial outwash. Less extensive are recent alluvium, sandy eolian material, glaciolacustrine deposits, material weathered from soft bedrock, and deposits of organic material.

Glacial till covers the entire county, but it is the surficial deposit on only two-thirds of the acreage (*10*). It is loam or clay loam. The layers of glacial till are very thin in areas where bedrock crops out. They are as much as 300 feet thick in preglacial river valleys. The till in these valleys is generally overlain by several feet of glacial outwash. The surficial glacial drift was deposited by three different substages of the Wisconsin Glaciation, approximately 10,000 to 55,000 years ago (*10*). There is very little difference among the three till sheets. As a result, the soils that formed in one till are similar to those that formed in the others. Barnes, Bowbells, Svea, and Williams soils formed in nearly level and undulating areas of till. Barnes, Buse, Williams, and Zahl soils formed in gently rolling to steep areas of till.

Glacial outwash is the surficial deposit in approximately one-third of the county. It is sandy or gravelly. It ranges from 3 to 40 feet in thickness. Most of the outwash was deposited during the last glacial substage. Divide, Fordville, and Renshaw soils formed in level to gently sloping areas of outwash. Arvilla and Sioux soils formed in nearly level to steep areas of outwash.

The recent alluvium in Kidder County is generally fine textured or moderately fine textured. Although the county has no integrated drainage pattern, small centripetal drainage patterns are around potholes and broad depressions. Local alluvium was deposited in these areas during the postglacial period. Parnell, Southam, and Tonka soils are in the deeper depressions that are often ponded. Colvin and Harriet soils are in the weakly expressed channels that are commonly between the deeper depressions.

Sandy eolian material has a high percentage of fine sand. Some of the deeper deposits occur as sand dunes oriented northwest to southeast. The eolian material also occurs as a thin mantle over other kinds of material, such as till. The source of this sandy material is local glacial outwash. Hecla and Maddock soils formed in nearly level and undulating areas of the eolian material. Serden and Maddock soils formed in gently rolling to steep areas, such as dunes.

The glaciolacustrine sediments in Kidder County are coarse textured to fine textured. They were deposited in depressional areas where water was dammed by an ice lobe during one of the glacial substages. Most of these deposits occur as layers of silt and clay. Overly soils formed in these deposits. Other areas of beach deposits are much coarser in texture. These sediments commonly have been reworked by the wind. Hecla, Maddock, and Ulen soils formed in these areas.

Bedrock crops out in some areas of the county. Most of the rock outcrops are Foxhills Sandstone. Vebar soils formed in sandstone residuum.

Markey soils formed in organic material. They are in wet areas where poor drainage has retarded the decay of plant remains. These soils are underlain by sand or loamy sand.

The physical and mineralogical character of the parent material has greatly influenced the physical and chemical properties of the soils. Some soils, such as Maddock loamy fine sand, formed in eolian or glaciolacustrine material that has a high content of sand. Other soils, such as Williams and Bowbells loams, formed in clay-rich glacial till. The more recent glacial sediments generally have a high content of secondary minerals, many of which are available to plants. Therefore, the soils that formed in glacial drift have a natural level of fertility that

is much higher than that of soils that formed in older, more weathered material. Most of the soils in the county have a high content of calcium carbonate at some depth within their profile. Divide and Hamerly soils have a high content of lime throughout. The saline phase of Colvin soils has inherited a high content of soluble salts from the parent material. Harriet and Miranda soils have inherited a high content of sodium salts.

Climate

Climate is a major factor in determining the kinds of soil that form in various parent materials. It affects the rate and intensity of hydrologic carbonation, oxidation, and other important chemical reactions in the soil. Temperature, rainfall, relative humidity, and length of the frost-free period affect the type of plant and animal life on and within the soil.

Local conditions modify the effect of the regional climate. The microclimate on south-facing slopes, for example, is warmer and less humid than that on north-facing slopes. The low lying, very poorly drained Parnell soils are wetter and cooler than the higher lying Barnes soils.

Kidder County is included in the climatic province of the semiarid Great Plains, which is characterized by variable annual precipitation; long, severe winters; and rather short, hot summers. Most of the precipitation falls between April and October.

About 8,500 to 4,500 years ago, the climate became warmer and drier, allowing prairie grasses to replace woody vegetation. The state was probably covered by short grasses and sage. This period was characterized by recurrent summer droughts and erosion. The climate became wetter again about 4,000 years ago. From about 5,000 years ago to the present, it has changed from a cool, humid climate to a warmer, drier one.

The soils in the southwestern part of the county are in the ustic soil moisture regime. Those in the rest of the county are in the udic soil moisture regime. Bowbells and Flaxton soils generally have ustic surface colors. In this county, however, their surface colors are more characteristic of the udic soil moisture regime.

Plant and Animal Life

Plant and animal life has important effects on soil formation. It especially affects the content of organic matter in the soil. As plants grow and die, biologic decay breaks down the biologic residue into humus. Humus is important for two major reasons. It promotes the formation of soil structure and thus good physical conditions for the growth of plant roots. It also helps to maintain fertility by retaining plant nutrients on its exchange complex and by slowly releasing them as it breaks down even further.

The native vegetation in Kidder County is dominantly short and mid grasses. The composition of these grasses varies from site to site. The short, cool-season grasses are dominant on the drier sites. The taller, warm-season grasses are more abundant on the more moist sites. The annual decomposition of grass residue below and above the surface has contributed to the thick, dark topsoil in many of the soils, such as Bowbells and Svea. These grasses help to maintain the supply of nutrients in the upper part of the profile. They withdraw nutrients from the lower parts of the profile and release them when the plant residue near the surface decomposes.

The activities of animal life play an important role in soil formation. The smaller animals and micro-organisms are responsible for the decomposition of plant and animal remains. The activities of burrowing insects and animals are responsible for mixing the soil. The upper 2 feet of some prairie soils probably is turned over by ants, worms, and rodents once every 100 years. The mixing action of animals recycles nutrients and clay minerals that are leached to the lower depths. This mixing also helps to aerate the upper part of the profile, thereby maintaining a good medium for the exchange of water and air.

Animals that live on the surface can also have an effect on soil formation. Through their effect on the plant community, grazing animals especially affect soil formation.

Relief

Relief affects soil formation mainly through its effects on the water regime. The processes of horizon differentiation change in intensity as the water regime becomes wetter. The depth to the water table and the rate of water infiltration are the most important factors that affect the water regime. They are affected by relief and topographic position.

In areas of nonintegrated drainage, such as Kidder County, the depth to the water table decreases from high to low topographic positions. More water penetrates the surface of the lower topographic positions, which receive runoff from the higher positions. The runoff rate increases with increasing slope.

As the soil moisture regime becomes wetter from the high to the low topographic positions, the conditions that affect the growth of plants generally improve. The plants affect the thickness and darkness of the surface horizon. Buse, Sioux, and Zahl soils generally are in gently rolling to steep areas. They show little evidence of horizon differentiation other than a thin, light colored surface horizon. Barnes and Williams soils are in nearly level to hilly areas. They show some evidence of horizon differentiation and have a relatively thick, dark surface horizon. Bowbells and Svea soils have a surface horizon that is thicker and darker than that of the Barnes and Williams soils because they are mainly in nearly level areas in swales.

Parnell, Southam, and Tonka soils are in the lowest topographic positions. They are often ponded for extended periods. Although these soils have a high content of nutrient-laden organic matter, the excessive wetness impedes the growth of most plants other than the water-tolerant ones. The surface horizon is thick and dark. The lower part of the profile, which contains less organic matter than the upper part, has a contrasting pattern of mottles or is gray. These colors indicate that these soils are poorly aerated because of saturation.

In places the soils in the lower topographic positions have a high content of soluble salts and sodium. The saline phase of Colvin soils, for example, has a high content of soluble salts. Harriet soils have a high content of sodium.

Time

In areas where the removal or addition of parent material is insignificant, time is an important factor affecting profile development. The rate and intensity of the processes of soil formation over time are ultimately responsible for the differentiation of genetic horizons. The longer these processes act at a given site, the more profound and distinct the differences among the horizons. At the beginning of soil formation, the changes are beneficial because they improve the conditions for plant growth. In very mature soils, however, most plant nutrients have been removed, the profile has become acid, and silicate clays have accumulated in thick, dense horizons.

The soils in relatively stable positions in Kidder County began to form shortly after the recession of the last glacier, about 10,000 years ago. Barnes and Williams soils are in many of these positions.

In areas where the removal or addition of parent material is significant, the soils are considered young because they show little or no evidence of profile development. The moderately sloping to steep Buse and Zahl soils are examples. Parnell and Southam soils, which are on unstable lowlands, also are examples.

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Glossary

Alkali (sodic) soil. A soil having so high a degree of alkalinity (pH 8.5 or higher), or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Blowout. A shallow depression from which all or most of the soil material has been removed by wind. A blowout has a flat or irregular floor formed by a resistant layer or by an accumulation of pebbles or cobbles. In some blowouts the water table is exposed.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Claypan. A slowly permeable soil horizon that contains much more clay than the horizons above it. A claypan is commonly hard when dry and plastic or stiff when wet.

Coarse textured soil. Sand or loamy sand.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures on a complex slope is difficult.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

Conservation tillage. A tillage system that does not invert the soil and that leaves a protective amount of crop residue on the surface throughout the year.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Deferred grazing. Postponing grazing or resting grazing land for a prescribed period.

Depth to rock (in tables). Bedrock is too near the surface for the specified use.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Drainage, surface. Runoff, or surface flow of water from an area.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Excess fines (in tables). Excess silt and clay in the soil. The soil is not a source of gravel or sand for construction purposes.

Excess salts (in tables). Excess water-soluble salts in the soil that restrict the growth of most plants.

Fallow. Cropland left idle in order to restore productivity through accumulation of moisture. Summer fallow is common in regions of limited rainfall where cereal grains are grown. The soil is tilled for at least one growing season for weed control and decomposition of plant residue.

Fast intake (in tables). The rapid movement of water into the soil.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Fibric soil material (peat). The least decomposed of all organic soil material. Peat contains a large amount of well preserved fiber that is readily identifiable according to botanical origin. Peat has the lowest bulk density and the highest water content at saturation of all organic soil material.

Fine textured soil. Sandy clay, silty clay, and clay.

Foot slope. The inclined surface at the base of a hill.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Glacial drift (geology). Pulverized and other rock material transported by glacial ice and then deposited. Also the sorted and unsorted material deposited by streams flowing from glaciers.

Glacial outwash (geology). Gravel, sand, and silt, commonly stratified, deposited by glacial meltwater.

Glacial till (geology). Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

Green manure crop (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Hemic soil material (mucky peat). Organic soil material intermediate in degree of decomposition between the less decomposed fibric and the more decomposed sapric material.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. The major horizons are as follows:

O horizon.—An organic layer of fresh and decaying plant residue.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, any plowed or disturbed surface layer.

E horizon.—The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

B horizon.—The mineral horizon below an O, A, or E horizon. The B horizon is in part a layer of transition from the overlying horizon to the underlying C horizon. The B horizon also has distinctive characteristics, such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) granular, prismatic, or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.

Cr horizon.—Soft, consolidated bedrock beneath the soil.

R layer.—Hard, consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon but can be directly below an A or a B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are—

Border.—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

Basin.—Water is applied rapidly to nearly level plains surrounded by levees or dikes.

Controlled flooding.—Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

Corrugation.—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.

Drip (or trickle).—Water is applied slowly and under low pressure to the surface of the soil or into the soil through such applicators as emitters, porous tubing, or perforated pipe.

Furrow.—Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.

Sprinkler.—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Subirrigation.—Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

Wild flooding.—Water, released at high points, is allowed to flow onto an area without controlled distribution.

Lacustrine deposit (geology). Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Large stones (in tables). Rock fragments 3 inches (7.6 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Leaching. The removal of soluble material from soil or other material by percolating water.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Moderately coarse textured soil. Coarse sandy loam, sandy loam, and fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, and silty clay loam.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Munsell notation. A designation of color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Outwash plain. A landform of mainly sandy or coarse textured material of glaciofluvial origin. An outwash plain is commonly smooth; where pitted, it is generally low in relief.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Peat. Unconsolidated material, largely undecomposed organic matter, that has accumulated under excess moisture. (See Fibric soil material).

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percs slowly (in tables). The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.2 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Ponding. Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

Poor filter (in tables). Because of rapid permeability the soil may not adequately filter effluent from a waste disposal system.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Rangeland. Land on which the potential natural vegetation is predominantly grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing. It includes natural grasslands, savannas, many wetlands, some deserts, tundras, and areas that support certain forb and shrub communities.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8

Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Saline soil. A soil containing soluble salts in an amount that impairs growth of plants. A saline soil does not contain excess exchangeable sodium.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sapric soil material (muck). The most highly decomposed of all organic soil material. Muck has the least amount of plant fiber, the highest bulk density, and the lowest water content at saturation of all organic soil material.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the substratum. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Similar soils. Soils that share limits of diagnostic criteria, behave and perform in a similar manner, and have similar conservation needs or management requirements for the major land uses in the survey area.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multipled by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slope (in tables). Slope is great enough that special practices are required to ensure satisfactory performance of the soil for a specific use.

Slow intake (in tables). The slow movement of water into the soil.

Small stones (in tables). Rock fragments less than 3 inches (7.6 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows:

	Millimeters
Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grain* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Stubble mulch. Stubble or other crop residue left on the soil or partly worked into the soil. It protects the soil from soil blowing and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Subsurface layer. An E horizon below an A horizon. If the E horizon is exposed, it is called the surface layer.

Summer fallow. The tillage of uncropped land during the summer to control weeds and allow storage of moisture in the soil for the growth of a later crop. A practice common in semiarid regions, where annual precipitation is not enough to produce a crop every

year. Summer fallow is frequently practiced before planting winter grain.

Surface layer. An A horizon 4 to 9 inches (10 to 24 centimeters) thick.

Surface soil. An A horizon 10 inches (25 centimeters) or more thick.

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Terminal moraine. A belt of thick glacial drift that generally marks the termination of important glacial advances.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Till plain. An extensive flat to undulating area underlain by glacial till.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Toe slope. The outermost inclined surface at the base of a hill; part of a foot slope.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

[Recorded in the period 1951-80 at Steele, North Dakota]

Month	Temperature						Precipitation				
	Average daily maximum	Average daily minimum	Average	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average number of growing degree days*	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	Units	In	In	In		In
January----	17.2	-4.2	6.5	45	-35	0	0.47	0.17	0.70	2	9.8
February---	24.9	2.9	13.9	50	-29	0	.42	.10	.67	2	7.2
March------	36.5	14.1	25.3	69	-21	16	.66	.16	1.04	2	9.3
April------	55.0	29.8	42.4	84	6	45	1.66	.60	2.52	4	6.2
May--------	69.1	41.2	55.2	91	22	197	2.62	1.29	3.77	6	1.2
June-------	77.3	51.5	64.4	96	35	432	3.61	1.92	5.08	7	.0
July-------	83.9	56.1	70.0	102	42	620	2.38	1.12	3.46	5	.0
August-----	83.7	54.1	68.9	102	37	586	1.67	.63	2.53	5	.0
September--	72.4	43.4	57.9	97	23	264	1.58	.39	2.52	4	.0
October----	60.8	33.2	47.0	87	12	75	.89	.25	1.39	3	1.4
November---	39.8	17.6	28.7	70	-13	0	.49	.08	.80	2	6.0
December---	24.9	4.1	14.5	53	-29	0	.46	.18	.68	2	9.1
Yearly:											
Average--	53.8	29.0	41.2	---	---	---	---	---	---	---	---
Extreme--	---	---	---	103	-35	---	---	---	---	---	---
Total----	---	---	---	---	---	2,235	16.91	13.85	19.77	44	50.2

* A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (40 degrees F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL

[Recorded in the period 1951-80 at Steele, North Dakota]

Probability	Temperature		
	24° F or lower	28° F or lower	32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	May 11	May 21	May 29
2 years in 10 later than--	May 6	May 17	May 25
5 years in 10 later than--	Apr. 27	May 8	May 16
First freezing temperature in fall:			
1 year in 10 earlier than--	Sept. 25	Sept. 10	Sept. 4
2 years in 10 earlier than--	Oct. 1	Sept. 15	Sept. 10
5 years in 10 earlier than--	Oct. 10	Sept. 26	Sept. 20

TABLE 3.--GROWING SEASON

[Recorded in the period 1951-80 at Steele, North Dakota]

Probability	Daily minimum temperature during growing season		
	Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
9 years in 10	146	118	110
8 years in 10	153	126	115
5 years in 10	166	140	126
2 years in 10	179	154	137
1 year in 10	186	162	142

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
2	Arveson loam, wet	6,020	0.7
3	Marysland loam	7,810	0.9
5	Harriet silt loam	10,090	1.1
7	Arveson-Ulen complex, 0 to 3 percent slopes	9,620	1.0
10	Minnewaukan and Stirum soils	12,520	1.3
14	Tonka loam	1,090	0.1
15	Parnell silty clay loam	9,380	1.0
16	Southam silty clay loam	23,040	2.5
17	Markey muck	2,180	0.2
19	Colvin silt loam, saline	1,940	0.2
20	Colvin silt loam	12,850	1.4
21D	Buse loam, 9 to 15 percent slopes	2,990	0.3
22B	Barnes-Svea loams, 1 to 6 percent slopes	41,410	4.5
22C	Barnes-Buse loams, 6 to 9 percent slopes	39,950	4.4
24B	Cresbard-Barnes loams, 1 to 6 percent slopes	1,470	0.2
28D	Buse-Svea loams, 3 to 15 percent slopes	34,480	3.8
29E	Barnes-Buse-Parnell complex, 0 to 35 percent slopes	58,320	6.4
32	Overly silt loam, 0 to 3 percent slopes	4,860	0.5
35B	Towner-Embden, loamy substratum complex, 1 to 6 percent slopes	21,810	2.4
35C	Towner-Barnes complex, 6 to 9 percent slopes	14,580	1.6
36B	Flaxton fine sandy loam, 1 to 6 percent slopes	19,590	2.1
37	Divide loam, 0 to 3 percent slopes	10,580	1.2
38D	Flaxton-Zahl complex, 6 to 12 percent slopes	7,630	0.8
39	Embden fine sandy loam, 1 to 3 percent slopes	2,230	0.2
42B	Barnes-Sioux sandy loams, 3 to 9 percent slopes	5,820	0.6
44	Fordville loam, 0 to 3 percent slopes	6,500	0.7
49B	Arvilla sandy loam, 1 to 6 percent slopes	93,070	10.2
49C	Arvilla sandy loam, 6 to 9 percent slopes	14,130	1.5
49D	Arvilla sandy loam, 9 to 15 percent slopes	5,960	0.7
52	Hamerly loam, 0 to 3 percent slopes	5,290	0.6
55B	Hecla-Ulen loamy fine sands, 1 to 6 percent slopes	18,220	2.0
56B	Maddock loamy fine sand, 1 to 6 percent slopes	42,060	4.6
61	Nutley silty clay, 1 to 3 percent slopes	3,470	0.4
61B	Nutley silty clay, 3 to 6 percent slopes	1,070	0.1
63C	Sioux-Arvilla sandy loams, 1 to 9 percent slopes	36,230	4.0
63E	Sioux-Arvilla sandy loams, 9 to 35 percent slopes	29,180	3.2
64B	Renshaw-Sioux loams, 1 to 6 percent slopes	32,160	3.5
65	Renshaw loam, 0 to 3 percent slopes	13,780	1.5
66C	Williams-Zahl loams, 6 to 9 percent slopes	24,770	2.7
66E	Williams-Zahl loams, 9 to 35 percent slopes	22,690	2.5
67	Williams-Bowbells loams, 1 to 3 percent slopes	27,480	3.0
67B	Williams-Bowbells loams, 3 to 6 percent slopes	46,990	5.1
69C	Maddock-Serden loamy fine sands, 3 to 9 percent slopes	7,040	0.8
69E	Serden loamy fine sand, 3 to 35 percent slopes	3,320	0.4
72B	Miranda loam, 0 to 6 percent slopes	7,810	0.9
74B	Williams-Noonan loams, 1 to 6 percent slopes	4,950	0.5
76	Letcher fine sandy loam, 0 to 3 percent slopes	1,670	0.2
92E	Buse-Barnes loams, 9 to 35 percent slopes	56,230	6.1
93E	Vebar-Williams complex, 9 to 35 percent slopes	1,620	0.2
	Water	47,250	5.2
	Total	915,200	100.0

TABLE 5.--YIELDS PER ACRE OF CROPS AND HAY

[Yields are those that can be expected under a high level of management. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil]

Soil name and map symbol	Spring wheat	Oats	Barley	Flax	Sunflowers	Corn silage	Bromegrass-alfalfa hay
	Bu	Bu	Bu	Bu	Lbs	Tons	Tons
2* Arveson	---	---	---	---	---	---	1.6
3* Marysland	---	---	---	---	---	---	1.6
5 Harriet	---	---	---	---	---	---	---
7* Arveson-Ulen	16	34	26	8	800	3.3	2.3
10 Minnewaukan and Stirum	---	---	---	---	---	---	---
14* Tonka	15	32	24	8	750	3.1	1.6
15 Parnell	---	---	---	---	---	---	---
16 Southam	---	---	---	---	---	---	---
17 Markey	---	---	---	---	---	---	---
19* Colvin	8	17	13	4	400	1.6	1.6
20* Colvin	---	---	---	---	---	---	2.0
21D Buse	---	---	---	---	---	---	1.3
22B Barnes-Svea	30	64	49	15	1,500	6.2	2.4
22C Barnes-Buse	19	40	31	10	950	3.9	2.2
24B Cresbard-Barnes	27	57	44	14	1,350	5.6	2.0
28D Buse-Svea	21	45	34	11	1,050	4.3	2.0
29E Barnes-Buse-Parnell	---	---	---	---	---	---	1.7
32 Overly	36	77	59	18	1,800	7.4	2.6
35B Towner-Embden	21	45	34	11	1,050	4.3	2.1
35C Towner-Barnes	17	36	28	9	850	3.5	2.2

See footnote at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS AND HAY--Continued

Soil name and map symbol	Spring wheat	Oats	Barley	Flax	Sunflowers	Corn silage	Bromegrass-alfalfa hay
	Bu	Bu	Bu	Bu	Lbs	Tons	Tons
36B------------------- Flaxton	26	55	42	13	1,300	5.3	2.1
37-------------------- Divide	24	51	39	12	1,200	4.9	2.3
38D------------------- Flaxton-Zahl	16	34	26	8	800	3.3	2.0
39-------------------- Embden	26	55	42	13	1,300	5.4	2.1
42B------------------- Barnes-Sioux	20	43	33	10	1,000	4.1	2.0
44-------------------- Fordville	22	47	36	11	1,100	4.5	2.3
49B------------------- Arvilla	16	34	26	8	800	3.3	1.7
49C------------------- Arvilla	12	26	20	6	600	2.5	1.7
49D------------------- Arvilla	---	---	---	---	---	---	1.7
52-------------------- Hamerly	30	64	49	15	1,500	6.2	2.4
55B------------------- Hecla-Ulen	17	36	28	9	850	3.5	1.8
56B------------------- Maddock	16	34	26	8	800	3.3	1.7
61-------------------- Nutley	31	66	50	16	1,550	6.4	2.3
61B------------------- Nutley	27	57	44	14	1,350	5.6	2.3
63C------------------- Sioux-Arvilla	---	---	---	---	---	---	1.2
63E------------------- Sioux-Arvilla	---	---	---	---	---	---	---
64B------------------- Renshaw-Sioux	13	28	21	7	650	2.7	1.4
65-------------------- Renshaw	17	36	28	9	850	3.5	1.4
66C------------------- Williams-Zahl	18	38	29	9	900	3.7	1.9
66E------------------- Williams-Zahl	---	---	---	---	---	---	---
67-------------------- Williams-Bowbells	31	66	50	16	1,550	6.4	2.5

See footnote at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS AND HAY--Continued

Soil name and map symbol	Spring wheat	Oats	Barley	Flax	Sunflowers	Corn silage	Bromegrass-alfalfa hay
	Bu	Bu	Bu	Bu	Lbs	Tons	Tons
67B----------------------- Williams-Bowbells	29	62	47	15	1,450	6.0	2.4
69C----------------------- Maddock-Serden	---	---	---	---	---	---	1.0
69E----------------------- Serden	---	---	---	---	---	---	---
72B----------------------- Miranda	---	---	---	---	---	---	---
74B----------------------- Williams-Noonan	21	45	34	11	1,050	4.3	1.9
76------------------------ Letcher	11	23	18	6	550	2.3	1.4
92E----------------------- Buse-Barnes	---	---	---	---	---	---	---
93E----------------------- Vebar-Williams	---	---	---	---	---	---	---

* Yields are for undrained areas.

TABLE 6.--RANGELAND PRODUCTIVITY

[Only the soils that support rangeland vegetation suitable for grazing are listed]

Soil name and map symbol	Range site	Potential annual production for kind of growing season: Favorable Lb/acre	Average Lb/acre	Unfavorable Lb/acre
2: Arveson	Wetland	6,400	5,800	5,200
3: Marysland	Subirrigated	6,000	5,500	4,400
5: Harriet	Saline Lowland	3,800	3,300	2,800
7*:				
Arveson	Subirrigated	4,900	4,400	3,900
Ulen	Limy Subirrigated	3,000	2,600	2,200
10*:				
Minnewaukan	Subirrigated	5,200	4,700	4,200
Stirum	Subirrigated	5,200	4,700	4,200
14: Tonka	Wet Meadow	5,000	4,650	4,300
15: Parnell	Wetland	6,600	6,000	4,800
19: Colvin	Saline Lowland	4,000	3,500	3,000
20: Colvin	Wetland	6,300	6,000	5,200
21D: Buse	Thin Upland	2,700	2,400	1,800
22B*:				
Barnes	Silty	3,000	2,750	2,500
Svea	Silty	3,000	2,700	2,500
22C*:				
Barnes	Silty	3,000	2,750	2,500
Buse	Thin Upland	2,700	2,400	1,800
24B*:				
Cresbard	Clayey	3,000	2,700	2,300
Barnes	Silty	3,000	2,750	2,500
28D*:				
Buse	Thin Upland	2,700	2,400	1,800
Svea	Silty	3,000	2,700	2,500
29E*:				
Barnes	Silty	3,000	2,750	2,500
Buse	Thin Upland	2,700	2,400	1,800
Parnell	Wetland	6,600	6,000	4,800

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY--Continued

Soil name and map symbol	Range site	Potential annual production for kind of growing season: Favorable Lb/acre	Average Lb/acre	Unfavorable Lb/acre
32 Overly	Silty	3,000	2,800	2,500
35B*:				
Towner	Sands	3,000	2,800	2,600
Embden	Sandy	3,400	2,900	2,400
35C*:				
Towner	Sands	3,000	2,800	2,600
Barnes	Silty	3,000	2,750	2,500
36B Flaxton	Sandy	3,000	2,600	2,200
37 Divide	Limy Subirrigated	4,800	4,200	3,600
38D*:				
Flaxton	Sandy	3,000	2,600	2,200
Zahl	Thin Upland	2,400	2,100	1,800
39 Embden	Sandy	3,400	2,900	2,400
42B*:				
Barnes	Silty	3,000	2,750	2,500
Sioux	Very Shallow	1,400	1,200	900
44 Fordville	Silty	3,200	2,700	1,900
49B, 49C, 49D Arvilla	Shallow to Gravel	2,200	1,900	1,700
52 Hamerly	Limy Subirrigated	4,800	4,200	3,600
55B*:				
Hecla	Sands	3,000	2,800	2,600
Ulen	Limy Subirrigated	3,000	2,600	2,200
56B Maddock	Sands	3,000	2,800	2,600
61, 61B Nutley	Clayey	3,000	2,500	1,800
63C*, 63E*:				
Sioux	Very Shallow	1,400	1,200	900
Arvilla	Shallow to Gravel	2,200	1,900	1,700
64B*:				
Renshaw	Shallow to Gravel	2,500	2,100	1,300
Sioux	Very Shallow	1,400	1,200	900

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY--Continued

Soil name and map symbol	Range site	Potential annual production for kind of growing season		
		Favorable	Average	Unfavorable
		Lb/acre	Lb/acre	Lb/acre
65 Renshaw	Shallow to Gravel	2,500	2,100	1,300
66C*, 66E*:				
Williams	Silty	3,000	2,600	2,100
Zahl	Thin Upland	2,400	2,100	1,800
67*:				
Williams	Silty	3,000	2,600	2,100
Bowbells	Overflow	3,800	3,300	2,800
67B*:				
Williams	Silty	3,000	2,600	2,100
Bowbells	Silty	3,000	2,500	2,100
69C*:				
Maddock	Sands	3,000	2,800	2,600
Serden	Thin Sands	2,200	1,900	1,600
69E Serden	Thin Sands	2,200	1,900	1,600
72B Miranda	Thin Claypan	1,600	1,300	800
74B*:				
Williams	Silty	3,000	2,600	2,100
Noonan	Claypan	2,000	1,700	1,400
76 Letcher	Sandy	3,200	2,900	2,500
92E*:				
Buse	Thin Upland	2,700	2,400	1,800
Barnes	Silty	3,000	2,750	2,500
93E*:				
Vebar	Sandy	3,000	2,600	2,200
Williams	Silty	3,000	2,600	2,100

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

[The symbol < means less than; > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil]

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
2. Arveson					
3. Marysland					
5. Harriet					
7*: Arveson.					
Ulen	Tatarian honeysuckle.	Eastern redcedar, Siberian crabapple, common chokecherry, lilac, American plum, Siberian peashrub, silver buffaloberry.	Green ash, bur oak, ponderosa pine, Russian-olive.	---	---
10*: Minnewaukan	American plum	Lilac, Tatarian honeysuckle, eastern redcedar, redosier dogwood, common chokecherry, Siberian peashrub.	Siberian crabapple, green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
Stirum.					
14. Tonka					
15. Parnell					
16. Southam					
17. Markey					
19. Colvin					
20 Colvin	---	American plum, Siberian peashrub, Tatarian honeysuckle, eastern redcedar, redosier dogwood, lilac.	Green ash, Black Hills spruce, Siberian crabapple.	Golden willow	Eastern cottonwood, Siberian elm.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
21D. Buse					
22B*:					
Barnes	---	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood, Tatarian honeysuckle.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---
Svea	---	Redosier dogwood, ponderosa pine, common chokecherry, Siberian peashrub, Tatarian honeysuckle, American plum.	Black Hills spruce, blue spruce, green ash, eastern redcedar.	Golden willow	Eastern cottonwood.
22C*:					
Barnes	---	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood, Tatarian honeysuckle.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---
Buse	Siberian peashrub, Tatarian honeysuckle, lilac.	Ponderosa pine, Russian-olive, eastern redcedar, Rocky Mountain juniper.	Siberian elm, green ash.	---	---
24B*:					
Cresbard	Tatarian honeysuckle, Peking cotoneaster.	Russian-olive, common chokecherry, eastern redcedar, silver buffaloberry, Siberian peashrub, lilac.	Green ash, ponderosa pine, Siberian elm, Siberian crabapple.	---	---
Barnes	---	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood, Tatarian honeysuckle.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---
28D*:					
Buse	Siberian peashrub, Tatarian honeysuckle, lilac.	Ponderosa pine, Russian-olive, eastern redcedar, Rocky Mountain juniper.	Siberian elm, green ash.	---	---

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
28D*:					
Svea	---	Redosier dogwood, ponderosa pine, common chokecherry, Siberian peashrub, Tatarian honeysuckle, American plum.	Black Hills spruce, blue spruce, green ash, eastern redcedar.	Golden willow	Eastern cottonwood.
29E*:					
Barnes	---	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood, Tatarian honeysuckle.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---
Buse.					
Parnell.					
32 Overly	---	Tatarian honeysuckle, ponderosa pine, Peking cotoneaster, redosier dogwood, eastern redcedar, American plum, common chokecherry, Siberian peashrub.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
35B*:					
Towner	---	Lilac, eastern redcedar, Siberian peashrub, common chokecherry, Tatarian honeysuckle, American plum, silver buffaloberry, Siberian crabapple.	Ponderosa pine, green ash, Russian-olive, bur oak.	---	---
Embden	---	Common chokecherry, American plum, ponderosa pine, Siberian peashrub, Peking cotoneaster, eastern redcedar, Tatarian honeysuckle, redosier dogwood.	Black Hills spruce, green ash.	Golden willow	Eastern cottonwood.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
35C*:					
Towner	---	Lilac, eastern redcedar, Siberian peashrub, common chokecherry, Tatarian honeysuckle, American plum, silver buffaloberry, Siberian crabapple.	Ponderosa pine, green ash, Russian-olive, bur oak.	---	---
Barnes	---	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood, Tatarian honeysuckle.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---
36B Flaxton	Lilac, silver buffaloberry, Tatarian honeysuckle.	Siberian crabapple, Siberian peashrub, eastern redcedar, common chokecherry, American plum, bur oak.	Ponderosa pine, green ash, Russian-olive.	---	---
37 Divide	---	Redosier dogwood, ponderosa pine, Tatarian honeysuckle, Peking cotoneaster, eastern redcedar, American plum, common chokecherry, Siberian peashrub.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
38D*:					
Flaxton	Lilac, silver buffaloberry, Tatarian honeysuckle.	Siberian crabapple, Siberian peashrub, eastern redcedar, common chokecherry, American plum, bur oak.	Ponderosa pine, green ash, Russian-olive.	---	---
Zahl.					

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
39. Embden	---	Peking cotoneaster, ponderosa pine, eastern redcedar, redosier dogwood, common chokecherry, Siberian peashrub, Tatarian honeysuckle, American plum.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
42B*:					
Barnes	---	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood, Tatarian honeysuckle.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---
Sioux.					
44. Fordville	Siberian peashrub, Tatarian honeysuckle, silver buffaloberry, lilac.	Rocky Mountain juniper, green ash, Siberian crabapple, common chokecherry, Russian-olive, eastern redcedar.	Ponderosa pine	---	---
49B, 49C, 49D. Arvilla	Tatarian honeysuckle, Siberian peashrub, lilac, silver buffaloberry.	Green ash, Russian-olive, Siberian crabapple, eastern redcedar, Rocky Mountain juniper, common chokecherry.	Ponderosa pine	---	---
52. Hamerly	---	Redosier dogwood, ponderosa pine, Tatarian honeysuckle, Peking cotoneaster, eastern redcedar, American plum, common chokecherry, Siberian peashrub.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
55B*:					
Hecla	---	Common chokecherry, American plum, ponderosa pine, Siberian peashrub, Peking cotoneaster, eastern redcedar, Tatarian honeysuckle, redosier dogwood.	Black Hills spruce, green ash.	Golden willow	Eastern cottonwood.
Ulen	Tatarian honeysuckle.	Eastern redcedar, Siberian crabapple, common chokecherry, lilac, American plum, Siberian peashrub, silver buffaloberry.	Green ash, bur oak, ponderosa pine, Russian-olive.	---	---
56B Maddock	---	Silver buffaloberry, common chokecherry, Siberian peashrub, eastern redcedar, Tatarian honeysuckle, American plum, Siberian crabapple, lilac.	Bur oak, green ash, ponderosa pine, Russian-olive.	---	---
61, 61B Nutley	Tatarian honeysuckle, Peking cotoneaster.	Russian-olive, eastern redcedar, common chokecherry, silver buffaloberry, Siberian peashrub, lilac.	Green ash, Siberian elm, ponderosa pine, Manchurian crabapple.	---	---
63C*, 63E*: Sioux.					
Arvilla	Tatarian honeysuckle, Siberian peashrub, lilac, silver buffaloberry.	Green ash, Russian-olive, Siberian crabapple, eastern redcedar, Rocky Mountain juniper, common chokecherry.	Ponderosa pine	---	---

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
64B*:					
Renshaw	Silver buffaloberry, Tatarian honeysuckle, Siberian peashrub, lilac.	Green ash, eastern redcedar, Siberian crabapple, Rocky Mountain juniper, common chokecherry.	Ponderosa pine, Russian-olive.	---	---
Sioux.					
65 Renshaw	Silver buffaloberry, Tatarian honeysuckle, Siberian peashrub, lilac.	Green ash, eastern redcedar, Siberian crabapple, Rocky Mountain juniper, common chokecherry.	Ponderosa pine, Russian-olive.	---	---
66C*:					
Williams	---	Russian-olive, eastern redcedar, lilac, Siberian peashrub, common chokecherry, Tatarian honeysuckle, American plum.	Siberian crabapple, green ash, ponderosa pine, bur oak, Black Hills spruce.	---	---
Zahl	Eastern redcedar, Siberian peashrub, Tatarian honeysuckle.	Ponderosa pine, green ash, Russian-olive, Rocky Mountain juniper.	Siberian elm	---	---
66E*:					
Williams.					
Zahl.					
67*, 67B*:					
Williams	---	Russian-olive, eastern redcedar, lilac, Siberian peashrub, common chokecherry, Tatarian honeysuckle, American plum.	Siberian crabapple, green ash, ponderosa pine, bur oak, Black Hills spruce.	---	---
Bowbells	---	Siberian crabapple, Tatarian honeysuckle, Peking cotoneaster, eastern redcedar, American plum, common chokecherry, Siberian peashrub.	Golden willow, green ash, ponderosa pine, Black Hills spruce.	---	Plains cottonwood.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
69C*:					
Maddock	---	Rocky Mountain juniper, eastern redcedar, ponderosa pine.	---	---	---
Serden	---	Ponderosa pine, eastern redcedar, Rocky Mountain juniper.	---	---	---
69E. Serden					
72B. Miranda					
74B*:					
Williams	---	Russian-olive, eastern redcedar, lilac, Siberian peashrub, common chokecherry, Tatarian honeysuckle, American plum.	Siberian crabapple, green ash, ponderosa pine, bur oak, Black Hills spruce.	---	---
Noonan	Green ash, Russian-olive, eastern redcedar, Rocky Mountain juniper, Siberian peashrub, silver buffaloberry.	Siberian elm, ponderosa pine.	---	---	---
76 Letcher	Rocky Mountain juniper, Siberian peashrub, silver buffaloberry.	Siberian elm, green ash, ponderosa pine, Russian-olive, eastern redcedar.	---	---	---
92E*:					
Buse.					
Barnes.					
93E*:					
Vebar.					
Williams.					

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 8.--RECREATIONAL DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe"]

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
2 Arveson	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
3 Marysland	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.
5 Harriet	Severe: flooding, wetness, percs slowly.	Severe: wetness, excess sodium, percs slowly.	Severe: wetness, percs slowly, excess sodium.	Severe: wetness.
7*:				
Arveson	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.
Ulen	Slight	Slight	Slight	Slight.
10*:				
Minnewaukan	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
Stirum	Severe: ponding, excess sodium.	Severe: ponding, excess sodium.	Severe: ponding, excess sodium.	Severe: ponding.
14 Tonka	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
15 Parnell	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
16 Southam	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
17 Markey	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.
19 Colvin	Severe: wetness, excess salt.	Severe: wetness, excess salt.	Severe: wetness, excess salt.	Severe: wetness.
20 Colvin	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
21D Buse	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
22B*:				
Barnes	Slight	Slight	Moderate: slope.	Slight.
Svea	Slight	Slight	Moderate: slope.	Slight.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
22C*:				
Barnes	Slight	Slight	Severe: slope.	Slight.
Buse	Slight	Slight	Severe: slope.	Slight.
24B*:				
Cresbard	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
Barnes	Slight	Slight	Moderate: slope.	Slight.
28D*:				
Buse	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Svea	Slight	Slight	Moderate: slope.	Slight.
29E*:				
Barnes	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Buse	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
Parnell	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
32 Overly	Slight	Slight	Slight	Slight.
35B*:				
Towner	Slight	Slight	Moderate: slope.	Slight.
Embden	Slight	Slight	Moderate: slope.	Slight.
35C*:				
Towner	Slight	Slight	Severe: slope.	Slight.
Barnes	Slight	Slight	Severe: slope.	Slight.
36B Flaxton	Slight	Slight	Moderate: slope.	Slight.
37 Divide	Slight	Slight	Slight	Slight.
38D*:				
Flaxton	Slight	Slight	Severe: slope.	Slight.
Zahl	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
39 Embden	Slight	Slight	Moderate: slope.	Slight.
42B*:				
Barnes	Slight	Slight	Severe: slope.	Slight.
Sioux	Slight	Slight	Severe: slope.	Slight.
44 Fordville	Slight	Slight	Slight	Slight.
49B Arvilla	Slight	Slight	Moderate: slope.	Slight.
49C Arvilla	Slight	Slight	Severe: slope.	Slight.
49D Arvilla	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
52 Hamerly	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Slight.
55B*:				
Hecla	Slight	Slight	Moderate: slope.	Slight.
Ulen	Slight	Slight	Moderate: slope.	Slight.
56B Maddock	Moderate: too sandy.	Moderate: too sandy	Moderate: slope, too sandy.	Moderate: too sandy.
61, 61B Nutley	Moderate: too clayey.	Moderate: too clayey.	Moderate: slope, too clayey.	Moderate: too clayey.
63C*:				
Sioux	Slight	Slight	Moderate: slope, small stones.	Slight.
Arvilla	Slight	Slight	Moderate: slope.	Slight.
63E*:				
Sioux	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
Arvilla	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
64B*:				
Renshaw	Slight	Slight	Moderate: slope.	Slight.
Sioux	Slight	Slight	Moderate: slope, small stones.	Slight.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
65 Renshaw	Slight	Slight	Slight	Slight.
66C*:				
Williams	Slight	Slight	Severe: slope.	Slight.
Zahl	Slight	Slight	Severe: slope.	Slight.
66E*:				
Williams	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
Zahl	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
67*, 67B*:				
Williams	Slight	Slight	Moderate: slope.	Slight.
Bowbells	Slight	Slight	Moderate: slope.	Slight.
69C*:				
Maddock	Moderate: too sandy.	Moderate: too sandy.	Severe: slope.	Moderate: too sandy.
Serden	Slight	Slight	Severe: slope.	Slight.
69E Serden	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
72B Miranda	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
74B*:				
Williams	Slight	Slight	Moderate: slope.	Slight.
Noonan	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
76 Letcher	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
92E*:				
Buse	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
Barnes	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
93E*:				
Vebar	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
Williams	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--WILDLIFE HABITAT

[See text for definitions of "good," "fair," "poor," and "very poor"]

Soil name and map symbol	Potential for habitat elements						Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Wetland wildlife	Rangeland wildlife
2 Arveson	Fair	Fair	Poor	Poor	Good	Good	Fair	Good	Poor.
3 Marysland	Fair	Fair	Fair	Fair	Good	Good	Fair	Good	Fair.
5 Harriet	Poor	Poor	Fair	Very poor	Good	Good	Poor	Good	Poor.
7*:									
Arveson	Fair	Fair	Fair	Fair	Good	Good	Fair	Good	Fair.
Ulen	Fair	Good	Good	Fair	Poor	Poor	Fair	Poor	Fair.
10*:									
Minnewaukan	Poor	Poor	Fair	Fair	Fair	Very poor	Poor	Poor	Fair.
Stirum	Very poor	Very poor	Very poor	Fair	Good	Fair	Very poor	Fair	Poor.
14 Tonka	Poor	Fair	Fair	Poor	Good	Good	Poor	Good	Poor.
15 Parnell	Very poor	Poor	Poor	Poor	Good	Good	Poor	Good	Poor.
16 Southam	Very poor	Very poor	Very poor	Very poor	Good	Good	Very poor	Good	Very poor.
17 Markey	Poor	Poor	Poor	Very poor	Good	Good	Poor	Good	Very poor.
19 Colvin	Poor	Fair	Poor	Fair	Good	Good	Poor	Good	Poor.
20 Colvin	Very poor	Poor	Poor	Poor	Good	Good	Poor	Good	Poor.
21D Buse	Fair	Fair	Fair	Fair	Very poor	Very poor	Fair	Very poor	Fair.
22B*:									
Barnes	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Svea	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
22C*:									
Barnes	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Buse	Fair	Good	Fair	Fair	Very poor	Very poor	Fair	Very poor	Fair.
24B*:									
Cresbard	Fair	Fair	Good	Poor	Very poor	Very poor	Fair	Very poor	Good.
Barnes	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.

See footnote at end of table.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Shrubs	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Wetland wildlife	Rangeland wildlife
28D*:									
Buse	Fair	Good	Fair	Fair	Very poor	Very poor	Fair	Very poor	Fair.
Svea	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
29E*:									
Barnes	Fair	Good	Good	Fair	Very poor	Very poor	Good	Very poor	Fair.
Buse	Poor	Poor	Fair	Fair	Very poor	Very poor	Poor	Very poor	Fair.
Parnell	Very poor	Poor	Poor	Poor	Good	Good	Poor	Good	Poor.
32 Overly	Good	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
35B*:									
Towner	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Embden	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
35C*:									
Towner	Poor	Fair	Good	Fair	Poor	Very poor	Fair	Very poor	Fair.
Barnes	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
36B Flaxton	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
37 Divide	Fair	Fair	Good	Fair	Fair	Very poor	Fair	Poor	Fair.
38D*:									
Flaxton	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Zahl	Poor	Fair	Good	Fair	Very poor	Very poor	Fair	Very poor	Fair.
39 Embden	Fair	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
42B*:									
Barnes	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Sioux	Very poor	Very poor	Poor	Poor	Very poor	Very poor	Very poor	Very poor	Poor.
44 Fordville	Fair	Good	Good	Fair	Very poor	Very poor	Fair	Very poor	Good.
49B, 49C Arvilla	Fair	Good	Fair	Poor	Very poor	Very poor	Fair	Very poor	Poor.
49D Arvilla	Poor	Fair	Fair	Poor	Very poor	Very poor	Fair	Very poor	Poor.
52 Hamerly	Good	Good	Good	Fair	Fair	Fair	Good	Fair	Fair.
55B*:									
Hecla	Fair	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
Ulen	Fair	Good	Good	Fair	Poor	Poor	Fair	Poor	Fair.

See footnote at end of table.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements						Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herba-ceous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Wetland wildlife	Rangeland wildlife
56B Maddock	Fair	Good	Good	Fair	Poor	Very poor	Fair	Very poor	Fair.
61, 61B Nutley	Fair	Fair	Poor	Poor	Poor	Very poor	Fair	Very poor	Poor.
63C*:									
Sioux	Very poor	Very poor	Poor	Poor	Very poor	Very poor	Very poor	Very poor	Poor.
Arvilla	Fair	Good	Fair	Poor	Very poor	Very poor	Fair	Very poor	Poor.
63E*:									
Sioux	Very poor	Very poor	Poor	Poor	Very poor	Very poor	Very poor	Very poor	Poor.
Arvilla	Poor	Fair	Fair	Poor	Very poor	Very poor	Fair	Very poor	Poor.
64B*:									
Renshaw	Poor	Fair	Poor	Poor	Very poor	Very poor	Poor	Very poor	Poor.
Sioux	Very poor	Very poor	Poor	Poor	Very poor	Very poor	Very poor	Very poor	Poor.
65 Renshaw	Poor	Fair	Poor	Poor	Very poor	Very poor	Poor	Very poor	Poor.
66C*:									
Williams	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Zahl	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
66E*:									
Williams	Poor	Fair	Good	Fair	Very poor	Very poor	Fair	Very poor	Fair.
Zahl	Poor	Fair	Good	Fair	Very poor	Very poor	Fair	Very poor	Fair.
67*:									
Williams	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Bowbells	Good	Good	Good	Good	Poor	Poor	Good	Poor	Good.
67B*:									
Williams	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Bowbells	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
69C*:									
Maddock	Poor	Fair	Good	Fair	Poor	Very poor	Fair	Very poor	Fair.
Serden	Poor	Fair	Fair	Good	Very poor	Very poor	Fair	Very poor	Fair.
69E Serden	Poor	Fair	Fair	Good	Very poor	Very poor	Fair	Very poor	Fair.
72B Miranda	Very poor	Very poor	Poor	Very poor	Very poor	Poor	Very poor	Very poor	Poor.
74B*:									
Williams	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Noonan	Poor	Poor	Very poor	Very poor	Poor	Very poor	Poor	Very poor	Very poor.

See footnote at end of table.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements						Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herba- ceous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Wetland wildlife	Rangeland wildlife
76------------------ Letcher	Poor	Poor	Poor	Fair	Fair	Poor	Poor	Poor	Poor.
92E*:									
Buse---------------	Poor	Poor	Fair	Fair	Very poor	Very poor	Poor	Very poor	Fair.
Barnes-------------	Poor	Fair	Good	Fair	Very poor	Very poor	Fair	Very poor	Fair.
93E*:									
Vebar--------------	Very poor	Poor	Good	Very poor	Very poor	Very poor	Poor	Very poor	Good.
Williams-----------	Poor	Fair	Good	Fair	Very poor	Very poor	Fair	Very poor	Fair.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--BUILDING SITE DEVELOPMENT

Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation]

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
2----------------- Arveson	Severe: cutbanks cave, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding, frost action.
3----------------- Marysland	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.
5----------------- Harriet	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: wetness, flooding, low strength.
7*:					
Arveson----------	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.
Ulen-------------	Severe: cutbanks cave.	Slight-----------	Moderate: wetness.	Slight------------	Moderate: frost action.
10*:					
Minnewaukan------	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
Stirum-----------	Severe: cutbanks cave, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
14---------------- Tonka	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: low strength, ponding, frost action.
15---------------- Parnell	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, low strength, frost action.
16---------------- Southam	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: low strength, ponding, frost action.
17---------------- Markey	Severe: cutbanks cave, excess humus, ponding.	Severe: ponding, low strength.	Severe: ponding.	Severe: ponding, low strength.	Severe: ponding, frost action, subsides.
19---------------- Colvin	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, wetness.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
20---------------- Colvin	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: low strength, ponding, frost action.
21D--------------- Buse	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Moderate: low strength, slope, frost action.
22B*:					
Barnes-----------	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: low strength, frost action.
Svea-------------	Moderate: wetness.	Moderate: shrink-swell.	Moderate: shrink-swell, wetness.	Moderate: shrink-swell.	Severe: low strength.
22C*:					
Barnes-----------	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: low strength, frost action.
Buse-------------	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: low strength, frost action.
24B*:					
Cresbard---------	Moderate: too clayey.	Severe: shrink-swell.	Moderate: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Barnes-----------	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: low strength, frost action.
28D*:					
Buse-------------	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Moderate: low strength, slope, frost action.
Svea-------------	Moderate: wetness.	Moderate: shrink-swell.	Moderate: shrink-swell, wetness.	Moderate: shrink-swell, slope.	Severe: low strength.
29E*:					
Barnes-----------	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Moderate: low strength, slope, frost action.
Buse-------------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Parnell----------	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, low strength, frost action.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
32 Overly	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.
35B*:					
Towner	Severe: cutbanks cave.	Slight	Moderate: wetness, shrink-swell.	Slight	Moderate: frost action.
Embden	Severe: cutbanks cave.	Slight	Moderate: wetness, shrink-swell.	Slight	Moderate: frost action.
35C*:					
Towner	Severe: cutbanks cave.	Slight	Moderate: wetness, shrink-swell.	Moderate: slope.	Moderate: frost action.
Barnes	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: low strength, frost action.
36B Flaxton	Severe: cutbanks cave.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
37 Divide	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Moderate: low strength, frost action.
38D*:					
Flaxton	Severe: cutbanks cave.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.
Zahl	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.
39 Embden	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Moderate: frost action.
42B*:					
Barnes	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: low strength, frost action.
Sioux	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight.
44 Fordville	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
49B Arvilla	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
49C Arvilla	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight.
49D Arvilla	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
52 Hamerly	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: frost action.
55B*:					
Hecla	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Moderate: frost action.
Ulen	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Moderate: frost action.
56B Maddock	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
61, 61B Nutley	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
63C*:					
Sioux	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight.
Arvilla	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight.
63E*:					
Sioux	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Arvilla	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.
64B*:					
Renshaw	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
Sioux	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
65 Renshaw	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
66C*:					
Williams	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.
Zahl	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.
66E*:					
Williams	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.
Zahl	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
67*:					
Williams	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
Bowbells	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
67B*:					
Williams	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.
Bowbells	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.
69C*:					
Maddock	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight.
Serden	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight.
69E Serden	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
72B Miranda	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
74B*:					
Williams	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
Noonan	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
76 Letcher	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Moderate: frost action.
92E*:					
Buse	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Barnes	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
93E*:					
Vebar	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Williams	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--SANITARY FACILITIES

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "poor," and other terms. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation]

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
2------------------ Arveson	Severe: ponding, poor filter.	Severe: seepage, ponding.	Severe: seepage, ponding, too sandy.	Severe: seepage, ponding.	Poor: seepage, too sandy, ponding.
3------------------ Marysland	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
5------------------ Harriet	Severe: flooding, wetness, percs slowly.	Severe: flooding, wetness.	Severe: flooding, wetness, excess sodium.	Severe: flooding, wetness.	Poor: hard to pack, wetness, excess sodium.
7*:					
Arveson-----------	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
Ulen--------------	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy.
10*:					
Minnewaukan--------	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
Stirum------------	Severe: ponding, poor filter.	Severe: seepage, ponding.	Severe: seepage, ponding, excess sodium.	Severe: seepage, ponding.	Poor: ponding, excess sodium.
14----------------- Tonka	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
15----------------- Parnell	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
16----------------- Southam	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
17 Markey	Severe: ponding, percs slowly, poor filter.	Severe: seepage, excess humus, ponding.	Severe: seepage, ponding, too sandy.	Severe: seepage, ponding.	Poor: seepage, too sandy, ponding.
19 Colvin	Severe: wetness, percs slowly.	Slight	Severe: wetness.	Severe: wetness.	Poor: wetness.
20 Colvin	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.
21D Buse	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
22B*:					
Barnes	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Svea	Severe: percs slowly.	Moderate: slope, seepage, wetness.	Severe: wetness.	Moderate: wetness.	Fair: too clayey.
22C*:					
Barnes	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Buse	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
24B*:					
Cresbard	Severe: percs slowly.	Moderate: slope.	Severe: excess sodium.	Slight	Poor: hard to pack, excess sodium.
Barnes	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
28D*:					
Buse	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
Svea	Severe: percs slowly.	Moderate: slope, seepage, wetness.	Severe: wetness.	Moderate: wetness.	Fair: too clayey.
29E*:					
Barnes	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
Buse	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
29E*:					
Parnell	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
32 Overly	Severe: percs slowly.	Slight	Moderate: too clayey.	Slight	Poor: thin layer.
35B*:					
Towner	Severe: wetness, percs slowly, poor filter.	Severe: seepage, wetness.	Moderate: wetness, too clayey.	Severe: seepage.	Fair: too clayey, wetness.
Embden	Severe: percs slowly.	Severe: seepage.	Severe: wetness.	Severe: seepage.	Fair: too clayey.
35C*:					
Towner	Severe: wetness, percs slowly, poor filter.	Severe: seepage, slope, wetness.	Moderate: wetness, too clayey.	Severe: seepage.	Fair: too clayey, wetness.
Barnes	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
36B Flaxton	Severe: percs slowly.	Severe: seepage.	Moderate: too clayey.	Severe: seepage.	Fair: too clayey.
37 Divide	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, small stones.
38D*:					
Flaxton	Severe: percs slowly.	Severe: seepage, slope.	Moderate: too clayey.	Severe: seepage.	Fair: too clayey.
Zahl	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
39 Embden	Moderate: wetness.	Severe: seepage.	Severe: seepage, wetness.	Severe: seepage.	Fair: too sandy.
42B*:					
Barnes	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Sioux	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
44: Fordville	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: small stones, too sandy, seepage.
49B: Arvilla	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
49C, 49D: Arvilla	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
52: Hamerly	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
55B*:					
Hecla	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: too sandy.
Ulen	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy.
56B: Maddock	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
61, 61B: Nutley	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight	Poor: too clayey, hard to pack.
63C*:					
Sioux	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
Arvilla	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
63E*:					
Sioux	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, small stones.
Arvilla	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
64B*:					
Renshaw	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
Sioux	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
65 Renshaw	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
66C*:					
Williams	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Zahl	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
66E*:					
Williams	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Zahl	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
67*, 67B*:					
Williams	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Bowbells	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
69C*:					
Maddock	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
Serden	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy, seepage.
69E Serden	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: too sandy, slope, seepage.
72B Miranda	Severe: percs slowly.	Moderate: slope.	Severe: excess sodium.	Slight	Poor: excess sodium.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
74B*:					
Williams	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Noonan	Severe: percs slowly.	Moderate: slope.	Severe: excess sodium.	Slight	Poor: excess sodium.
76 Letcher	Severe: wetness, percs slowly.	Moderate: seepage, wetness.	Severe: excess sodium.	Slight	Poor: excess sodium.
92E*:					
Buse	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Barnes	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
93E*:					
Vebar	Severe: depth to rock, slope.	Severe: seepage, depth to rock, slope.	Severe: depth to rock, seepage, slope.	Severe: depth to rock, seepage, slope.	Poor: depth to rock, slope.
Williams	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--CONSTRUCTION MATERIALS

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," and other terms. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation]

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
2----------------- Arveson	Poor: wetness.	Probable-----------	Improbable: too sandy.	Poor: wetness.
3----------------- Marysland	Fair: wetness.	Probable-----------	Probable-----------	Fair: area reclaim, small stones, thin layer.
5----------------- Harriet	Poor: wetness, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness, excess sodium.
7*:				
Arveson-----------	Fair: wetness.	Probable-----------	Improbable: too sandy.	Fair: small stones, thin layer.
Ulen--------------	Fair: wetness.	Probable-----------	Improbable: too sandy.	Fair: too sandy.
10*:				
Minnewaukan-------	Poor: wetness.	Probable-----------	Improbable: too sandy.	Poor: small stones, wetness.
Stirum------------	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness, excess sodium.
14---------------- Tonka	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, wetness.
15---------------- Parnell	Poor: wetness, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
16---------------- Southam	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
17---------------- Markey	Poor: wetness.	Probable-----------	Improbable: too sandy.	Poor: excess humus, wetness.
19---------------- Colvin	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salt, wetness.
20---------------- Colvin	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
21D------------------ Buse	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
22B*:				
Barnes---------------	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Svea-----------------	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
22C*:				
Barnes---------------	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Buse-----------------	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
24B*:				
Cresbard-------------	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess sodium.
Barnes---------------	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
28D*:				
Buse-----------------	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
Svea-----------------	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
29E*:				
Barnes---------------	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
Buse-----------------	Fair: low strength, slope, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Parnell--------------	Poor: wetness, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
32------------------- Overly	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
35B*:				
Towner---------------	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
35B*:				
Embden	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Good.
35C*:				
Towner	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
Barnes	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
36B Flaxton	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
37 Divide	Fair: wetness.	Probable	Probable	Poor: small stones, area reclaim.
38D*:				
Flaxton	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Zahl	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
39 Embden	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
42B*:				
Barnes	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Sioux	Good	Probable	Probable	Poor: small stones, area reclaim.
44 Fordville	Good	Probable	Probable	Fair: thin layer.
49B, 49C, 49D Arvilla	Good	Probable	Probable	Poor: small stones, area reclaim.
52 Hamerly	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
55B*:				
Hecla	Good	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
Ulen	Fair: wetness.	Probable	Improbable: too sandy.	Fair: too sandy.
56B Maddock	Good	Probable	Improbable: too sandy.	Poor: too sandy.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
61, 61B Nutley	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
63C*:				
Sioux	Good	Probable	Probable	Poor: small stones, area reclaim.
Arvilla	Good	Probable	Probable	Poor: small stones, area reclaim.
63E*:				
Sioux	Fair: slope.	Probable	Probable	Poor: small stones, area reclaim, slope.
Arvilla	Good	Probable	Probable	Poor: small stones, area reclaim.
64B*:				
Renshaw	Good	Probable	Probable	Poor: small stones, area reclaim.
Sioux	Good	Probable	Probable	Poor: small stones, area reclaim.
65 Renshaw	Good	Probable	Probable	Poor: small stones, area reclaim.
66C*:				
Williams	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: large stones.
Zahl	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
66E*:				
Williams	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Zahl	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
67*, 67B*:				
Williams	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: large stones.
Bowbells	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
69C*:				
Maddock	Good	Probable	Improbable: too sandy.	Poor: too sandy.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
69C*:				
Serden	Good	Probable	Improbable: too sandy.	Fair: too sandy.
69E Serden	Fair: slope.	Probable	Improbable: too sandy.	Poor: slope.
72B Miranda	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess sodium.
74B*:				
Williams	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: large stones.
Noonan	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess sodium.
76 Letcher	Fair: thin layer.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess sodium.
92E*:				
Buse	Fair: low strength, slope, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Barnes	Fair: low strength, slope, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
93E*:				
Vebar	Poor: depth to rock.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Williams	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--WATER MANAGEMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation]

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
2----------------- Arveson	Severe: seepage.	Severe: seepage, piping, ponding.	Ponding, frost action, cutbanks cave.	Ponding---------	Ponding, too sandy.	Wetness.
3----------------- Marysland	Severe: seepage.	Severe: seepage, wetness.	Frost action, cutbanks cave.	Wetness---------	Wetness, too sandy.	Wetness.
5----------------- Harriet	Slight----------	Severe: piping, wetness, excess sodium.	Percs slowly, flooding, frost action.	Wetness, percs slowly.	Erodes easily, wetness.	Wetness, excess sodium, erodes easily.
7*:						
Arveson-----------	Severe: seepage.	Severe: seepage, piping, wetness.	Frost action, cutbanks cave.	Wetness---------	Wetness, too sandy.	Wetness.
Ulen--------------	Severe: seepage.	Severe: seepage, piping.	Cutbanks cave	Wetness, soil blowing.	Wetness, too sandy, soil blowing.	Favorable.
10*:						
Minnewaukan-------	Severe: seepage.	Severe: seepage, piping, wetness.	Cutbanks cave	Wetness, droughty.	Wetness, too sandy, soil blowing.	Wetness, droughty.
Stirum------------	Severe: seepage.	Severe: seepage, piping, ponding.	Ponding, cutbanks cave, excess salt.	Ponding, droughty, fast intake.	Ponding, too sandy, soil blowing.	Wetness, excess salt, excess sodium.
14---------------- Tonka	Slight----------	Severe: ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Erodes easily, ponding, percs slowly.	Wetness, erodes easily, percs slowly.
15---------------- Parnell	Slight----------	Severe: hard to pack, ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Ponding, percs slowly.	Wetness, percs slowly.
16---------------- Southam	Slight----------	Severe: hard to pack, ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Erodes easily, ponding, percs slowly.	Wetness, excess salt, erodes easily.
17---------------- Markey	Severe: seepage.	Severe: seepage, piping, ponding.	Ponding, subsides, frost action.	Ponding, soil blowing.	Ponding, too sandy, soil blowing.	Wetness.
19---------------- Colvin	Moderate: seepage.	Severe: wetness.	Percs slowly, frost action.	Wetness, percs slowly.	Wetness, percs slowly.	Wetness, excess salt, percs slowly.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
20------ Colvin	Moderate: seepage.	Severe: ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Ponding, percs slowly.	Wetness, percs slowly.
21D------ Buse	Severe: slope.	Severe: piping.	Deep to water	Slope------	Slope, erodes easily.	Slope, erodes easily.
22B*:						
Barnes------	Moderate: slope.	Severe: piping.	Deep to water	Slope------	Erodes easily	Erodes easily.
Svea------	Moderate: slope, seepage.	Severe: piping.	Deep to water	Slope------	Erodes easily	Erodes easily.
22C*:						
Barnes------	Moderate: slope.	Severe: piping.	Deep to water	Slope------	Erodes easily	Erodes easily.
Buse------	Moderate: slope.	Severe: piping.	Deep to water	Slope------	Erodes easily	Erodes easily.
24B*:						
Cresbard------	Moderate: slope.	Severe: excess sodium.	Deep to water	Percs slowly, slope, excess sodium.	Favorable------	Excess sodium, percs slowly.
Barnes------	Moderate: slope.	Severe: piping.	Deep to water	Slope------	Erodes easily	Erodes easily.
28D*:						
Buse------	Severe: slope.	Severe: piping.	Deep to water	Slope------	Slope, erodes easily.	Slope, erodes easily.
Svea------	Moderate: slope, seepage.	Severe: piping.	Deep to water	Slope------	Erodes easily	Erodes easily.
29E*:						
Barnes------	Severe: slope.	Severe: piping.	Deep to water	Slope------	Slope, erodes easily.	Slope, erodes easily.
Buse------	Severe: slope.	Severe: piping.	Deep to water	Slope------	Slope, erodes easily.	Slope, erodes easily.
Parnell------	Slight------	Severe: hard to pack, ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Ponding, percs slowly.	Wetness, percs slowly.
32------ Overly	Slight------	Severe: piping.	Deep to water	Percs slowly---	Favorable------	Percs slowly.
35B*:						
Towner------	Severe: seepage.	Severe: piping.	Deep to water	Droughty, fast intake, soil blowing	Erodes easily, soil blowing.	Erodes easily, droughty.
Embden------	Severe: seepage.	Severe: piping.	Deep to water	Soil blowing, slope, excess salt.	Soil blowing---	Favorable.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
35C*:						
Towner	Severe: seepage.	Severe: piping.	Deep to water	Droughty, fast intake, soil blowing.	Erodes easily, soil blowing.	Erodes easily, droughty.
Barnes	Moderate: slope.	Severe: piping.	Deep to water	Soil blowing, slope.	Erodes easily, soil blowing.	Erodes easily.
36B Flaxton	Severe: seepage.	Severe: piping.	Deep to water	Soil blowing, slope.	Erodes easily, soil blowing.	Erodes easily.
37 Divide	Severe: seepage.	Severe: seepage.	Cutbanks cave	Wetness	Wetness, too sandy.	Favorable.
38D*:						
Flaxton	Severe: seepage.	Severe: piping.	Deep to water	Soil blowing, slope.	Erodes easily, soil blowing.	Erodes easily.
Zahl	Severe: slope.	Moderate: piping.	Deep to water	Percs slowly, slope.	Slope, erodes easily, percs slowly.	Slope, erodes easily, percs slowly.
39 Embden	Severe: seepage.	Severe: seepage, piping.	Deep to water	Soil blowing	Soil blowing	Favorable.
42B*:						
Barnes	Moderate: slope.	Severe: piping.	Deep to water	Soil blowing, slope.	Erodes easily, soil blowing.	Erodes easily.
Sioux	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, slope.	Too sandy	Droughty.
44 Fordville	Severe: seepage.	Severe: seepage.	Deep to water	Favorable	Too sandy	Favorable.
49B, 49C Arvilla	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, soil blowing, slope.	Too sandy, soil blowing.	Droughty.
49D Arvilla	Severe: seepage, slope.	Severe: seepage.	Deep to water	Droughty, soil blowing, slope.	Slope, too sandy, soil blowing.	Slope, droughty.
52 Hamerly	Moderate: seepage.	Severe: piping.	Frost action	Wetness	Erodes easily, wetness.	Erodes easily.
55B*:						
Hecla	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.
Ulen	Severe: seepage.	Severe: seepage, piping.	Slope, cutbanks cave.	Wetness, soil blowing.	Wetness, too sandy, soil blowing.	Favorable.
56B Maddock	Severe: seepage.	Severe: seepage, piping.	Deep to water	Slope, droughty, fast intake.	Too sandy, soil blowing.	Droughty.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
61---------------- Nutley	Slight---------	Moderate: hard to pack.	Deep to water	Slow intake----	Percs slowly---	Percs slowly.
61B--------------- Nutley	Moderate: slope.	Moderate: hard to pack.	Deep to water	Slope, slow intake.	Percs slowly---	Percs slowly.
63C*:						
Sioux------------	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, slope.	Too sandy------	Droughty.
Arvilla----------	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, soil blowing, slope.	Too sandy, soil blowing.	Droughty.
63E*:						
Sioux------------	Severe: seepage, slope.	Severe: seepage.	Deep to water	Droughty, slope.	Slope, too sandy.	Droughty, slope.
Arvilla----------	Severe: seepage, slope.	Severe: seepage.	Deep to water	Droughty, soil blowing, slope.	Slope, too sandy, soil blowing.	Slope, droughty.
64B*:						
Renshaw----------	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, slope.	Too sandy------	Droughty.
Sioux------------	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, slope.	Too sandy------	Droughty.
65---------------- Renshaw	Severe: seepage.	Severe: seepage.	Deep to water	Droughty-------	Too sandy------	Droughty.
66C*:						
Williams---------	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Percs slowly, slope.	Erodes easily	Erodes easily, percs slowly.
Zahl-------------	Moderate: slope.	Moderate: piping.	Deep to water	Percs slowly, slope.	Erodes easily, percs slowly.	Erodes easily, percs slowly.
66E*:						
Williams---------	Severe: slope.	Moderate: piping.	Deep to water	Percs slowly, slope.	Slope, erodes easily.	Slope, erodes easily, percs slowly.
Zahl-------------	Severe: slope.	Moderate: piping.	Deep to water	Percs slowly, slope.	Slope, erodes easily, percs slowly.	Slope, erodes easily, percs slowly.
67*:						
Williams---------	Moderate: seepage.	Moderate: piping.	Deep to water	Percs slowly---	Erodes easily	Erodes easily, percs slowly.
Bowbells---------	Moderate: seepage.	Moderate: piping.	Deep to water	Percs slowly---	Erodes easily, percs slowly.	Erodes easily, percs slowly.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
67B*:						
Williams----------	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Percs slowly, slope.	Erodes easily	Erodes easily, percs slowly.
Bowbells----------	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Percs slowly, slope.	Erodes easily, percs slowly.	Erodes easily, percs slowly.
69C*:						
Maddock-----------	Severe: seepage.	Severe: seepage, piping.	Deep to water	Slope, droughty, fast intake.	Too sandy, soil blowing.	Droughty.
Serden------------	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.
69E---------------- Serden	Severe: seepage, slope.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Slope, too sandy, soil blowing.	Slope, droughty.
72B---------------- Miranda	Moderate: slope.	Severe: excess sodium.	Deep to water	Percs slowly, excess sodium, excess salt.	Percs slowly---	Excess sodium, percs slowly.
74B*:						
Williams----------	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Percs slowly, slope.	Erodes easily	Erodes easily, percs slowly.
Noonan------------	Moderate: slope.	Severe: piping, excess sodium.	Deep to water	Percs slowly, slope, excess sodium.	Percs slowly---	Excess sodium, percs slowly.
76----------------- Letcher	Moderate: seepage.	Severe: piping, excess sodium.	Deep to water	Soil blowing, percs slowly, excess sodium.	Too sandy, soil blowing.	Excess sodium, percs slowly.
92E*:						
Buse--------------	Severe: slope.	Severe: piping.	Deep to water	Slope-----------	Slope, erodes easily.	Slope, erodes easily.
Barnes------------	Severe: slope.	Severe: piping.	Deep to water	Slope-----------	Slope, erodes easily.	Slope, erodes easily.
93E*:						
Vebar-------------	Severe: seepage, slope.	Severe: piping.	Deep to water	Soil blowing, depth to rock, slope.	Slope, depth to rock, soil blowing.	Slope, depth to rock.
Williams----------	Severe: slope.	Moderate: piping.	Deep to water	Percs slowly, slope.	Slope, erodes easily.	Slope, erodes easily, percs slowly.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--ENGINEERING INDEX PROPERTIES

[The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated]

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
2----------------- Arveson	0-8	Loam-------------	ML	A-4	0	100	95-100	85-90	50-80	20-40	NP-10
	8-22	Fine sandy loam, sandy loam, loam.	SM, SM-SC	A-4	0	100	95-100	60-85	35-50	<20	NP-5
	22-60	Fine sand, loamy sand, sandy loam.	SP-SM, SM, SM-SC	A-3, A-2, A-4	0	100	95-100	50-80	5-45	<20	NP-5
3----------------- Marysland	0-7	Loam-------------	CL	A-6, A-7	0	95-100	95-100	85-95	50-80	30-50	10-25
	7-25	Loam, clay loam, sandy clay loam.	CL, SC	A-6	0	90-100	85-100	80-95	45-80	20-40	10-20
	25-60	Stratified fine sand to gravelly coarse sand.	SP-SM, SM	A-1, A-2, A-3	0	70-95	50-90	35-70	5-20	---	NP
5----------------- Harriet	0-1	Silt loam--------	CL, CL-ML	A-4, A-6	0	100	100	85-100	60-90	25-40	5-20
	1-9	Clay loam, silty clay loam, silty clay.	CL, CH	A-7, A-6	0	100	100	90-100	70-100	35-70	20-40
	9-60	Stratified very fine sandy loam to silty clay.	CL, CL-ML, CH	A-4, A-6, A-7	0	100	100	90-100	60-100	20-65	5-40
7*:											
Arveson----------	0-13	Loam-------------	ML	A-4	0-1	100	95-100	85-90	50-80	20-40	NP-10
	13-42	Fine sandy loam, sandy loam, loam.	SM, SM-SC	A-4	0	100	95-100	60-85	35-50	<20	NP-5
	42-60	Fine sand, loamy sand, sandy loam.	SP-SM, SM, SM-SC	A-3, A-2, A-4	0	100	95-100	50-80	5-45	<20	NP-5
Ulen-------------	0-12	Loamy fine sand	SM	A-4, A-2	0	100	100	80-100	20-50	<20	NP-4
	12-24	Loamy fine sand, fine sand.	SM	A-2	0	100	95-100	70-95	12-35	---	NP
	24-60	Fine sand--------	SP-SM, SM	A-3, A-2	0	100	95-100	80-100	5-35	---	NP
10*:											
Minnewaukan------	0-3	Sandy loam-------	SM, SM-SC	A-2, A-1	0	90-100	90-100	40-55	15-35	---	NP-5
	3-60	Loamy fine sand, loamy sand, sand.	SM, SP-SM	A-2, A-3	0	90-100	70-100	50-100	5-35	---	NP
Stirum-----------	0-3	Loamy sand-------	SM	A-2, A-4	0	100	100	50-80	20-40	---	NP
	3-20	Loam, fine sandy loam, sandy loam.	SC, CL, ML, SM	A-2, A-4	0	100	100	60-95	30-75	15-30	NP-10
	20-60	Stratified silt loam to loamy sand.	SM, CL, ML, SC	A-2, A-4	0	100	100	50-100	15-90	<30	NP-10
14---------------- Tonka	0-16	Loam, silt loam	CL, CL-ML	A-4, A-6	0-2	100	95-100	90-100	70-90	20-40	5-25
	16-53	Silty clay loam, clay loam, clay.	CH, CL	A-6, A-7	0-2	100	95-100	90-100	75-95	35-55	15-35
	53-60	Silty clay loam, clay loam, loam.	CL, CL-ML	A-6, A-7, A-4	0-3	90-100	85-100	75-100	55-90	25-50	5-30

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
15---------------- Parnell	0-7	Silty clay loam	CL, CH	A-7	0	100	100	95-100	85-95	40-60	15-30
	7-42	Clay loam, silty clay loam, silty clay.	CL, CH	A-7	0	100	95-100	90-100	70-95	40-80	20-50
	42-60	Clay loam, silty clay loam, silty clay.	CL, CH	A-6, A-7	0	95-100	90-100	80-100	70-95	30-80	15-50
16---------------- Southam	0-18	Silty clay loam	CL	A-6, A-7	0	100	95-100	90-100	85-100	30-50	10-25
	18-28	Silty clay, clay, silty clay loam.	CL, CH	A-7	0	100	95-100	90-100	85-100	40-75	15-50
	28-60	Silty clay, silty clay loam, clay.	CL, CH	A-6, A-7	0	100	95-100	90-100	80-100	30-75	10-50
17---------------- Markey	0-28	Sapric material	PT	A-8	---	---	---	---	---	---	---
	28-60	Sand, loamy sand, fine sand.	SP, SM, SP-SM	A-2, A-3	0	100	75-100	60-75	0-20	---	NP
19---------------- Colvin	0-13	Silt loam--------	CL	A-6	0	100	100	90-100	80-95	20-35	10-20
	13-60	Silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	80-95	20-50	10-30
20---------------- Colvin	0-7	Silt loam--------	CL	A-6	0	100	100	90-100	80-95	25-40	10-20
	7-42	Silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	80-95	25-50	10-30
	42-60	Loam, silt loam, clay loam.	CL	A-6, A-7	0	100	100	90-100	70-95	25-50	10-25
21D--------------- Buse	0-7	Loam-------------	ML, CL, CL-ML	A-4, A-6	0	90-100	85-95	70-95	55-90	20-40	3-20
	7-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0	90-100	85-100	70-90	60-85	25-40	5-20
22B*:											
Barnes----------	0-8	Loam-------------	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	80-100	60-90	20-40	5-20
	8-19	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	19-32	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	32-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
Svea------------	0-7	Loam-------------	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	80-95	60-90	20-40	5-25
	7-23	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-90	20-45	5-25
	23-60	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-85	20-50	5-30
22C*:											
Barnes----------	0-7	Loam-------------	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	80-100	60-90	20-40	5-20
	7-13	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	13-32	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	32-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
Buse------------	0-7	Loam-------------	ML, CL, CL-ML	A-4, A-6	0	90-100	85-95	70-95	55-90	20-40	3-20
	7-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0	90-100	85-100	70-90	60-85	25-40	5-20
24B*:											
Cresbard--------	0-5	Loam-------------	ML, CL	A-4, A-6	0	100	100	85-100	60-80	30-40	5-15
	5-21	Clay loam, silty clay, clay.	CL, CH	A-7	0	100	100	90-100	70-90	40-60	15-30
	21-29	Clay loam, silty clay, clay.	CL, CH	A-7	0	100	100	85-100	70-90	40-60	15-30
	29-60	Clay loam, loam	CL, CH, ML	A-6, A-7	0-5	100	100	85-100	60-80	35-55	10-27

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
24B*:											
Barnes----------	0-8	Loam-------------	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	80-100	60-90	20-40	5-20
	8-19	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	19-32	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	32-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
28D*:											
Buse------------	0-7	Loam-------------	ML, CL, CL-ML	A-4, A-6	0	90-100	85-95	70-95	55-90	20-40	3-20
	7-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0	90-100	85-100	70-90	60-85	25-40	5-20
Svea------------	0-7	Loam-------------	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	80-95	60-90	20-40	5-25
	7-23	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-90	20-45	5-25
	23-60	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-85	20-50	5-30
29E*:											
Barnes----------	0-6	Loam-------------	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	80-100	60-90	20-40	5-20
	6-17	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	17-31	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	31-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
Buse------------	0-7	Loam-------------	ML, CL, CL-ML	A-4, A-6	0	90-100	85-95	70-95	55-90	20-40	3-20
	7-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0	90-100	85-100	70-90	60-85	25-40	5-20
Parnell---------	0-6	Silty clay loam	CL, CH	A-7	0	100	100	95-100	85-95	40-60	15-30
	6-31	Clay loam, silty clay loam, silty clay.	CL, CH	A-7	0	100	95-100	90-100	70-95	40-80	20-50
	31-60	Clay loam, silty clay loam, silty clay.	CL, CH	A-6, A-7	0	95-100	90-100	80-95	70-95	30-80	15-50
32--------------- Overly	0-15	Silt loam--------	CL, CL-ML	A-6, A-7, A-4	0	100	100	90-100	85-100	25-45	5-25
	15-28	Silty clay loam, silt loam, clay loam.	CL, CL-ML	A-6, A-7, A-4	0	100	100	90-100	80-100	25-50	5-30
	28-60	Stratified silt loam to silty clay.	CL, CL-ML	A-6, A-7, A-4	0	100	100	90-100	80-100	25-50	5-30
35B*:											
Towner----------	0-18	Loamy fine sand	SM, SM-SC	A-2	0	100	100	50-80	15-35	<25	NP-5
	18-33	Loamy sand, loamy fine sand, fine sand.	SM, SM-SC, SW-SM	A-2, A-3	0	100	95-100	50-80	5-35	<25	NP-5
	33-60	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	85-95	55-80	25-50	5-30
Embden----------	0-22	Fine sandy loam	SM, ML	A-2, A-4	0	100	100	60-95	30-65	<35	NP-10
	22-29	Fine sandy loam, sandy loam.	SM	A-2, A-4	0	100	100	60-85	30-50	---	NP
	29-52	Fine sandy loam, sandy loam, loamy fine sand.	SM	A-2, A-4	0	100	100	50-80	15-50	---	NP
	52-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
35C*:											
Towner----------	0-19	Loamy fine sand	SM, SM-SC	A-2	0	100	100	50-80	15-35	<25	NP-5
	19-31	Loamy sand, loamy fine sand, fine sand.	SM, SM-SC, SW-SM	A-2, A-3	0	100	95-100	50-80	5-35	<25	NP-5
	31-60	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	85-95	55-80	25-50	5-30
Barnes----------	0-8	Sandy loam-------	SM, SC, SM-SC	A-4, A-2, A-6	0-5	90-100	85-100	60-70	30-40	20-40	NP-15
	8-19	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	19-29	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	29-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
36B-------------- Flaxton	0-6	Fine sandy loam	SM, ML	A-4	0	100	100	70-85	40-55	<30	NP-5
	6-21	Fine sandy loam, loamy fine sand.	SM	A-2, A-4	0	100	100	60-95	25-45	<30	NP-5
	21-60	Clay loam, loam, sandy clay loam.	CL, CL-ML, ML	A-4, A-6, A-7	0-5	85-100	80-100	75-95	60-80	25-45	5-25
37--------------- Divide	0-7	Loam-------------	CL, CL-ML	A-4, A-6	0	95-100	95-100	85-95	60-85	25-40	5-20
	7-26	Loam, clay loam, gravelly loam.	CL, CL-ML	A-4, A-6	0-3	95-100	80-100	60-90	55-80	20-40	5-20
	26-60	Stratified sand to gravelly sand.	GM, SM, GP-GM, SP-SM	A-1	0-5	25-75	15-65	10-40	5-25	---	NP
38D*:											
Flaxton---------	0-6	Fine sandy loam	SM, ML	A-4	0	100	100	70-85	40-55	<30	NP-5
	6-21	Fine sandy loam, loamy fine sand.	SM	A-2, A-4	0	100	100	60-95	25-45	<30	NP-5
	21-60	Clay loam, loam, sandy clay loam.	CL, CL-ML, ML	A-4, A-6, A-7	0-5	85-100	80-100	75-95	60-80	25-45	5-25
Zahl------------	0-8	Loam-------------	CL	A-6	0-1	95-100	95-100	80-95	55-75	25-40	10-20
	8-18	Loam, clay loam	CL	A-6	0-1	95-100	90-100	80-95	60-80	25-40	10-20
	18-60	Clay loam, loam	CL	A-6	0-1	95-100	90-100	80-95	60-80	25-40	10-20
39--------------- Embden	0-11	Fine sandy loam	SM, ML	A-2, A-4	0	100	100	60-95	30-65	<35	NP-10
	11-29	Fine sandy loam, sandy loam.	SM	A-2, A-4	0	100	100	60-85	30-50	---	NP
	29-60	Fine sandy loam, sandy loam, fine sand.	SM	A-2, A-4	0	100	100	50-80	15-50	---	NP
42B*:											
Barnes----------	0-6	Sandy loam-------	SM, SC, SM-SC	A-4, A-2, A-6	0-5	90-100	85-100	60-70	30-40	20-40	NP-15
	6-19	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	19-28	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	28-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
Sioux-----------	0-8	Sandy loam-------	SM	A-4	0-5	95-100	85-100	60-85	35-45	20-30	NP-7
	8-12	Gravelly loam, gravelly sandy loam, gravelly loamy sand.	SM, GM	A-4, A-2, A-1	0-5	60-90	50-80	45-70	15-50	20-35	NP-7
	12-60	Extremely gravelly sand, very gravelly loamy sand, very gravelly sand.	GM, GP, SM, SP	A-1	0	25-75	20-60	5-35	0-25	<25	NP-5

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
44--------------- Fordville	0-8	Loam-------------	ML, CL	A-4, A-6, A-7	0	100	100	70-85	55-75	30-45	5-20
	8-29	Loam, silt loam, clay loam.	CL, ML	A-4, A-6, A-7	0	100	95-100	70-95	55-80	30-45	5-20
	29-60	Gravelly loamy sand, gravelly sand, very gravelly sand.	SW, SW-SM, SM	A-1	0	65-85	45-70	15-45	0-15	<25	NP-5
49B, 49C, 49D---- Arvilla	0-16	Sandy loam-------	SM, SC, SM-SC	A-2, A-4, A-6	0	95-100	90-100	50-80	20-45	10-40	NP-15
	16-60	Gravelly coarse sand, coarse sand, very gravelly coarse sand.	SP-SM, GP, SP, GP-GM	A-1, A-2, A-3	0	35-100	25-100	10-60	0-10	---	NP
52--------------- Hamerly	0-7	Loam-------------	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	60-90	20-40	5-20
	7-36	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-75	20-45	5-25
	36-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-75	20-45	5-25
55B*:											
Hecla-----------	0-8	Loamy fine sand	SM, SM-SC	A-2	0	100	95-100	85-100	12-35	15-30	NP-7
	8-29	Loamy sand, loamy fine sand, fine sand.	SM, SM-SC	A-2	0	100	95-100	85-100	12-35	15-30	NP-7
	29-60	Loamy sand, fine sand, loamy fine sand.	SM, SM-SC	A-2	0	100	95-100	85-100	10-35	15-30	NP-7
Ulen------------	0-12	Loamy fine sand	SM	A-4, A-2	0	100	100	80-100	20-50	<20	NP-4
	12-24	Loamy fine sand, fine sand.	SM	A-2	0	100	95-100	70-95	12-35	---	NP
	24-60	Fine sand--------	SP-SM, SM	A-3, A-2	0	100	95-100	80-100	5-35	---	NP
56B-------------- Maddock	0-16	Loamy fine sand	SM	A-2	0	100	100	50-80	15-35	---	NP
	16-60	Loamy sand, loamy fine sand, fine sand.	SM, SP-SM	A-2, A-3	0	95-100	95-100	60-100	5-35	---	NP
61, 61B---------- Nutley	0-8	Silty clay-------	CH	A-7	0	100	100	95-100	85-100	50-70	25-40
	8-60	Clay, silty clay, silty clay loam.	CH	A-7	0	100	100	95-100	85-100	50-70	25-40
63C*:											
Sioux-----------	0-8	Sandy loam-------	SM	A-4	0-5	95-100	85-100	60-85	35-45	20-30	NP-7
	8-12	Gravelly loam, gravelly sandy loam, gravelly loamy sand.	SM, GM	A-4, A-2, A-1	0-5	60-90	50-80	45-70	15-50	20-35	NP-7
	12-60	Extremely gravelly sand, very gravelly loamy sand, very gravelly sand.	GM, GP, SM, SP	A-1	0	25-75	20-60	5-35	0-25	<25	NP-5

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
63C*:											
Arvilla	0-16	Sandy loam	SM, SC, SM-SC	A-2, A-4, A-6	0	95-100	90-100	50-80	20-45	10-40	NP-15
	16-60	Gravelly coarse sand, coarse sand, very gravelly coarse sand.	SP-SM, GP, SP, GP-GM	A-1, A-2, A-3	0	35-100	25-100	10-60	0-10	---	NP
63E*:											
Sioux	0-7	Sandy loam	SM	A-4	0-5	95-100	85-100	60-85	35-45	20-30	NP-7
	7-11	Gravelly loam, gravelly sandy loam, gravelly loamy sand.	SM, GM	A-4, A-2, A-1	0-5	60-90	50-80	45-70	15-50	20-35	NP-7
	11-60	Extremely gravelly sand, very gravelly loamy sand, very gravelly sand.	GM, GP, SM, SP	A-1	0	25-75	20-60	5-35	0-25	<25	NP-5
Arvilla	0-16	Sandy loam	SM, SC, SM-SC	A-2, A-4, A-6	0	95-100	90-100	50-80	20-45	10-40	NP-15
	16-60	Gravelly coarse sand, coarse sand, very gravelly coarse sand.	SP-SM, GP, SP, GP-GM	A-1, A-2, A-3	0	35-100	25-100	10-60	0-10	---	NP
64B*:											
Renshaw	0-8	Loam	ML, CL	A-4, A-6	0-5	95-100	90-100	70-100	50-75	30-40	5-15
	8-17	Loam, sandy clay loam, gravelly loam.	SM-SC, SC, ML, CL	A-4, A-6	0-5	95-100	55-100	45-90	35-70	25-40	3-15
	17-60	Gravelly loamy sand, very gravelly loamy sand, gravelly sand.	SW, SM, SW-SM, GW-GM	A-1	0-5	45-95	30-80	10-50	0-15	<25	NP-5
Sioux	0-7	Loam	ML, CL	A-4, A-6	0-5	95-100	85-100	70-90	55-75	30-40	5-15
	7-12	Gravelly loam, gravelly sandy loam, gravelly loamy sand.	SM, GM	A-4, A-2, A-1	0-5	60-90	50-80	45-70	15-50	20-35	NP-7
	12-60	Extremely gravelly sand, very gravelly loamy sand, very gravelly sand.	GM, GP, SM, SP	A-1	0	25-75	20-60	5-35	0-25	<25	NP-5
65 Renshaw	0-7	Loam	ML, CL	A-4, A-6	0-5	95-100	90-100	70-100	50-75	30-40	5-15
	7-19	Loam, sandy clay loam, gravelly loam.	SM-SC, SC, ML, CL	A-4, A-6	0-5	95-100	55-100	45-90	35-70	25-40	3-15
	19-60	Gravelly loamy sand, very gravelly loamy sand, gravelly sand.	SW, SM, SW-SM, GW-GM	A-1	0-5	45-95	30-80	10-50	0-15	<25	NP-5

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
66C*, 66E*:											
Williams	0-5	Loam	CL, ML	A-4, A-6, A-7	0-5	95-100	95-100	85-95	60-90	25-45	3-20
	5-13	Clay loam, loam	CL	A-6, A-7	0-5	95-100	95-100	80-100	60-80	30-50	10-30
	13-60	Clay loam, loam	CL	A-6, A-7	0-5	95-100	95-100	80-100	60-80	30-50	10-30
Zahl	0-6	Loam	CL	A-6	0-1	95-100	95-100	80-95	55-75	25-40	10-20
	6-26	Loam, clay loam	CL	A-6	0-1	95-100	90-100	80-95	60-80	25-40	10-20
	26-60	Clay loam, loam	CL	A-6	0-1	95-100	90-100	80-95	60-80	25-40	10-20
67*, 67B*:											
Williams	0-7	Loam	CL, ML	A-4, A-6, A-7	0-5	95-100	95-100	85-95	60-90	25-45	3-20
	7-14	Clay loam, loam	CL	A-6, A-7	0-5	95-100	95-100	80-100	60-80	30-50	10-30
	14-60	Clay loam, loam	CL	A-6, A-7	0-5	95-100	95-100	80-100	60-80	30-50	10-30
Bowbells	0-13	Loam	CL, ML, CL-ML	A-4, A-6	0-5	95-100	90-100	85-95	60-90	20-40	3-23
	13-32	Loam, clay loam	CL	A-6, A-7	0-5	95-100	90-100	80-95	60-80	20-45	10-25
	32-60	Loam, clay loam	CL	A-6, A-7	0-5	95-100	90-100	80-95	60-80	20-45	10-25
69C*:											
Maddock	0-14	Loamy fine sand	SM	A-2	0	100	100	50-80	15-35	---	NP
	14-60	Loamy sand, loamy fine sand, fine sand.	SM, SP-SM	A-2, A-3	0	95-100	95-100	60-100	5-35	---	NP
Serden	0-4	Loamy fine sand	SM	A-2	0	100	100	65-85	15-25	---	NP
	4-60	Fine sand, sand	SM, SP-SM	A-2, A-3	0	100	100	65-85	5-25	---	NP
69E Serden	0-4	Loamy fine sand	SM	A-2	0	100	100	65-85	15-25	---	NP
	4-60	Fine sand, sand	SM, SP-SM	A-2, A-3	0	100	100	65-85	5-25	---	NP
72B Miranda	0-7	Loam, silt loam	CL-ML, CL, ML	A-4, A-6	0	100	100	85-95	60-85	25-40	5-15
	7-12	Loam, clay loam	CL, ML	A-6, A-7	0-5	95-100	95-100	85-95	50-80	30-50	10-20
	12-60	Loam, clay loam, silty clay loam.	CL, ML	A-6, A-7	0-5	95-100	95-100	85-95	50-80	30-50	10-20
74B*:											
Williams	0-7	Loam	CL, ML	A-4, A-6, A-7	0-5	95-100	95-100	85-95	60-90	25-45	3-20
	7-14	Clay loam, loam	CL	A-6, A-7	0-5	95-100	95-100	80-100	60-80	30-50	10-30
	14-60	Clay loam, loam	CL	A-6, A-7	0-5	95-100	95-100	80-100	60-80	30-50	10-30
Noonan	0-11	Loam	CL, CL-ML	A-4, A-6	0-1	95-100	95-100	80-95	55-75	20-40	5-25
	11-18	Clay loam	CL, CH	A-6, A-7	0-1	95-100	95-100	85-95	65-80	25-60	10-35
	18-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-1	95-100	95-100	80-95	60-80	25-50	5-25
76 Letcher	0-13	Fine sandy loam	SM, SM-SC	A-4	0	100	100	60-95	35-50	<30	NP-7
	13-16	Fine sandy loam, sandy loam.	SM, SM-SC	A-4	0	100	100	60-95	35-50	<30	NP-7
	16-50	Fine sandy loam, sandy loam, loamy sand.	SM, SM-SC	A-2, A-4	0	100	100	60-95	20-45	<30	NP-7
	50-60	Silty clay loam, silty clay, loam.	CH, CL	A-7	0	100	100	95-100	80-95	45-70	25-50

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag- ments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
92E*:											
Buse------------	0-7	Loam-------------	ML, CL, CL-ML	A-4, A-6	0	90-100	85-95	70-95	55-90	20-40	3-20
	7-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0	90-100	85-100	70-90	60-85	25-40	5-20
Barnes----------	0-5	Loam-------------	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	80-100	60-90	20-40	5-20
	5-15	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	15-31	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	31-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
93E*:											
Vebar-----------	0-5	Fine sandy loam	SM, ML	A-4, A-2	0	95-100	90-100	60-100	30-55	---	NP
	5-31	Fine sandy loam, loamy fine sand, sandy loam.	SM, ML	A-4, A-2	0	95-100	90-100	60-100	30-55	---	NP
	31-60	Weathered bedrock	---	---	---	---	---	---	---	---	---
Williams--------	0-6	Loam-------------	CL, ML	A-4, A-6, A-7	0-5	95-100	95-100	85-95	60-90	25-45	3-20
	6-13	Clay loam, loam	CL	A-6, A-7	0-5	95-100	95-100	80-100	60-80	30-50	10-30
	13-60	Clay loam, loam	CL	A-6, A-7	0-5	95-100	95-100	80-100	60-80	30-50	10-30

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

[The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated]

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH	mmhos/cm				
2---------------- Arveson	0-8	2.0-6.0	0.16-0.18	7.4-8.4	<2	Low--------	0.24	4	4L
	8-22	0.6-6.0	0.15-0.17	7.4-8.4	<2	Low--------	0.24		
	22-60	2.0-20	0.05-0.15	7.4-8.4	<2	Low--------	0.17		
3---------------- Marysland	0-7	0.6-2.0	0.17-0.22	7.9-8.4	<2	Moderate	0.28	4	4L
	7-25	0.6-2.0	0.15-0.19	7.9-8.4	<2	Moderate	0.28		
	25-60	>6.0	0.02-0.07	7.9-8.4	<2	Low--------	0.15		
5---------------- Harriet	0-1	0.06-0.2	0.20-0.24	6.6-8.4	<2	Moderate	0.37	3	6
	1-9	<0.06	0.10-0.15	>7.3	4-16	High-------	0.37		
	9-60	0.06-0.2	0.10-0.15	>7.8	4-16	Moderate	0.37		
7*:									
Arveson----------	0-13	2.0-6.0	0.16-0.18	7.4-8.4	<2	Low--------	0.24	4	4L
	13-42	0.6-6.0	0.15-0.17	7.4-8.4	<2	Low--------	0.24		
	42-60	2.0-20	0.05-0.15	7.4-8.4	<2	Low--------	0.17		
Ulen-------------	0-12	6.0-20	0.16-0.18	7.9-8.4	<4	Low--------	0.17	4	2
	12-24	6.0-20	0.10-0.12	7.9-8.4	<4	Low--------	0.17		
	24-60	6.0-20	0.06-0.08	7.9-8.4	<4	Low--------	0.17		
10*:									
Minnewaukan------	0-3	6.0-20	0.05-0.10	7.4-8.4	2-4	Low--------	0.15	4	3
	3-60	6.0-20	0.05-0.10	7.4-8.4	2-4	Low--------	0.15		
Stirum-----------	0-3	2.0-6.0	0.06-0.12	7.9-8.4	2-8	Low--------	0.17	3	2
	3-20	0.2-0.6	0.12-0.18	>7.8	2-16	Low--------	0.32		
	20-60	0.6-20	0.06-0.18	>7.8	2-16	Low--------	0.17		
14---------------- Tonka	0-16	0.6-2.0	0.18-0.23	5.6-7.3	<2	Low--------	0.32	5	6
	16-53	0.06-0.2	0.14-0.19	5.6-7.8	<2	High-------	0.43		
	53-60	0.2-0.6	0.14-0.19	6.6-9.0	<2	Moderate	0.43		
15---------------- Parnell	0-7	0.2-0.6	0.18-0.22	6.1-7.8	<2	Moderate	0.28	5	7
	7-42	0.06-0.2	0.13-0.19	6.6-7.8	<2	High-------	0.28		
	42-60	0.06-0.2	0.11-0.19	6.6-8.4	<2	High-------	0.28		
16---------------- Southam	0-18	0.2-0.6	0.18-0.23	6.6-8.4	2-8	Moderate	0.37	5	4
	18-28	0.06-0.2	0.14-0.20	6.6-8.4	2-8	High-------	0.28		
	28-60	0.06-0.6	0.13-0.17	7.4-9.0	2-8	High-------	0.28		
17---------------- Markey	0-28	0.2-6.0	0.35-0.45	4.5-7.8	<2	-----------	----	2	2
	28-60	6.0-20	0.03-0.08	4.5-8.4	<2	Low--------	----		
19---------------- Colvin	0-13	0.6-2.0	0.15-0.17	7.4-9.0	4-16	Moderate	0.32	5	4L
	13-60	0.06-2.0	0.11-0.15	7.4-9.0	4-16	Moderate	0.32		
20---------------- Colvin	0-7	0.6-2.0	0.20-0.22	7.4-9.0	<2	Moderate	0.32	5	4L
	7-42	0.06-2.0	0.16-0.20	7.4-9.0	<2	Moderate	0.32		
	42-60	0.06-2.0	0.15-0.20	7.4-9.0	<2	Moderate	0.32		
21D--------------- Buse	0-7	0.2-2.0	0.17-0.22	6.6-8.4	<2	Moderate	0.28	5	4L
	7-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH	mmhos/cm				
22B*:									
Barnes----------	0-8	0.6-2.0	0.13-0.24	6.1-7.8	<2	Low-------	0.28	5	6
	8-19	0.6-2.0	0.15-0.19	6.1-7.8	<4	Moderate	0.28		
	19-32	0.2-0.6	0.14-0.19	7.4-8.4	<4	Moderate	0.37		
	32-60	0.2-0.6	0.14-0.19	7.4-8.4	<8	Moderate	0.37		
Svea------------	0-7	0.6-2.0	0.20-0.24	6.6-7.8	<2	Low-------	0.28	5	6
	7-23	0.6-2.0	0.17-0.22	6.6-7.8	<2	Moderate	0.28		
	23-60	0.2-2.0	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
22C*:									
Barnes----------	0-7	0.6-2.0	0.13-0.24	6.1-7.8	<2	Low-------	0.28	5	6
	7-13	0.6-2.0	0.15-0.19	6.1-7.8	<4	Moderate	0.28		
	13-32	0.2-0.6	0.14-0.19	7.4-8.4	<4	Moderate	0.37		
	32-60	0.2-0.6	0.14-0.19	7.4-8.4	<8	Moderate	0.37		
Buse------------	0-7	0.2-2.0	0.17-0.22	6.6-8.4	<2	Moderate	0.28	5	4L
	7-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
24B*:									
Cresbard--------	0-5	0.6-2.0	0.17-0.20	5.6-7.3	<2	Low-------	0.32	3	6
	5-21	0.06-0.6	0.11-0.14	5.6-7.3	2-4	High------	0.32		
	21-29	0.06-0.6	0.11-0.15	6.1-8.4	2-4	High------	0.32		
	29-60	0.2-0.6	0.16-0.20	7.4-9.0	2-8	Moderate	0.32		
Barnes----------	0-8	0.6-2.0	0.13-0.24	6.1-7.8	<2	Low-------	0.28	5	6
	8-19	0.6-2.0	0.15-0.19	6.1-7.8	<4	Moderate	0.28		
	19-32	0.2-0.6	0.14-0.19	7.4-8.4	<4	Moderate	0.37		
	32-60	0.2-0.6	0.14-0.19	7.4-8.4	<8	Moderate	0.37		
28D*:									
Buse------------	0-7	0.2-2.0	0.17-0.22	6.6-8.4	<2	Moderate	0.28	5	4L
	7-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
Svea------------	0-7	0.6-2.0	0.20-0.24	6.6-7.8	<2	Low-------	0.28	5	6
	7-23	0.6-2.0	0.17-0.22	6.6-7.8	<2	Moderate	0.28		
	23-60	0.2-2.0	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
29E*:									
Barnes----------	0-6	0.6-2.0	0.13-0.24	6.1-7.8	<2	Low-------	0.28	5	6
	6-17	0.6-2.0	0.15-0.19	6.1-7.8	<4	Moderate	0.28		
	17-31	0.2-0.6	0.14-0.19	7.4-8.4	<4	Moderate	0.37		
	31-60	0.2-0.6	0.14-0.19	7.4-8.4	<8	Moderate	0.37		
Buse------------	0-7	0.2-2.0	0.17-0.22	6.6-8.4	<2	Moderate	0.28	5	4L
	7-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
Parnell---------	0-6	0.2-0.6	0.18-0.22	6.1-7.8	<2	Moderate	0.28	5	7
	6-31	0.06-0.2	0.13-0.19	6.6-7.8	<2	High------	0.28		
	31-60	0.06-0.2	0.11-0.19	6.6-8.4	<2	High------	0.28		
32--------------- Overly	0-15	0.2-0.6	0.22-0.24	6.6-7.8	<2	Moderate	0.32	5	6
	15-28	0.2-0.6	0.17-0.22	6.6-8.4	<2	Moderate	0.32		
	28-60	0.06-0.6	0.13-0.22	7.9-8.4	<2	Moderate	0.32		
35B*:									
Towner----------	0-18	6.0-20	0.08-0.12	6.6-7.8	<2	Low-------	0.17	5	2
	18-33	6.0-20	0.06-0.13	6.6-7.8	<2	Low-------	0.17		
	33-60	0.2-2.0	0.14-0.22	7.4-8.4	<2	Moderate	0.37		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors		Wind erodibility group
							K	T	
	In	In/hr	In/in	pH	mmhos/cm				
35B*:									
Embden----------	0-22	2.0-6.0	0.13-0.18	6.6-7.3	<2	Low-------	0.20	5	3
	22-29	2.0-6.0	0.12-0.17	6.6-7.3	<2	Low-------	0.20		
	29-52	2.0-6.0	0.06-0.16	7.4-8.4	<2	Low-------	0.20		
	52-60	0.2-0.6	0.14-0.19	7.4-8.4	<8	Moderate	0.37		
35C*:									
Towner----------	0-19	6.0-20	0.08-0.12	6.6-7.8	<2	Low-------	0.17	5	2
	19-31	6.0-20	0.06-0.13	6.6-7.8	<2	Low-------	0.17		
	31-60	0.2-2.0	0.14-0.22	7.4-8.4	<2	Moderate	0.37		
Barnes----------	0-8	0.6-2.0	0.13-0.15	6.1-7.8	<2	Low-------	0.20	5	3
	8-19	0.6-2.0	0.15-0.19	6.1-7.8	<4	Moderate	0.28		
	19-29	0.2-0.6	0.14-0.19	7.4-8.4	<4	Moderate	0.37		
	29-60	0.2-0.6	0.14-0.19	7.4-8.4	<8	Moderate	0.37		
36B-------------- Flaxton	0-6	2.0-6.0	0.16-0.18	6.6-7.3	<2	Low-------	0.20	5	3
	6-21	2.0-6.0	0.15-0.17	6.6-7.3	<2	Low-------	0.20		
	21-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
37--------------- Divide	0-7	0.6-2.0	0.18-0.22	7.4-8.4	<2	Low-------	0.28	4	4L
	7-26	0.6-2.0	0.16-0.19	7.9-8.4	<2	Low-------	0.28		
	26-60	>6.0	0.03-0.07	7.9-8.4	<2	Low-------	0.10		
38D*:									
Flaxton---------	0-6	2.0-6.0	0.16-0.18	6.6-7.3	<2	Low-------	0.20	5	3
	6-21	2.0-6.0	0.15-0.17	6.6-7.3	<2	Low-------	0.20		
	21-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
Zahl------------	0-8	0.6-2.0	0.17-0.22	6.6-7.8	<2	Moderate	0.28	5	4L
	8-18	0.6-2.0	0.15-0.19	7.4-8.4	<2	Moderate	0.37		
	18-60	0.06-0.6	0.15-0.19	7.4-8.4	<2	Moderate	0.37		
39--------------- Embden	0-11	2.0-6.0	0.13-0.18	6.6-7.3	<2	Low-------	0.20	5	3
	11-29	2.0-6.0	0.12-0.17	6.6-7.8	<2	Low-------	0.20		
	29-60	2.0-6.0	0.06-0.16	7.4-8.4	<2	Low-------	0.20		
42B*:									
Barnes----------	0-6	0.6-2.0	0.13-0.15	6.1-7.8	<2	Low-------	0.20	5	3
	6-19	0.6-2.0	0.15-0.19	6.1-7.8	<4	Moderate	0.28		
	19-28	0.2-0.6	0.14-0.19	7.4-8.4	<4	Moderate	0.37		
	28-60	0.2-0.6	0.14-0.19	7.4-8.4	<8	Moderate	0.37		
Sioux-----------	0-8	2.0-6.0	0.11-0.15	6.6-8.4	<2	Low-------	0.20	2	3
	8-12	2.0-6.0	0.10-0.15	7.4-8.4	<2	Low-------	0.20		
	12-60	>6.0	0.03-0.06	7.4-8.4	<2	Low-------	0.10		
44--------------- Fordville	0-8	0.6-2.0	0.18-0.20	6.1-7.3	<2	Low-------	0.24	4	6
	8-29	0.6-2.0	0.18-0.21	6.1-7.8	<2	Moderate	0.24		
	29-60	6.0-20	0.03-0.06	7.4-8.4	<2	Low-------	0.10		
49B, 49C, 49D---- Arvilla	0-16	2.0-6.0	0.13-0.15	6.6-8.4	<2	Low-------	0.20	3	3
	16-60	>6.0	0.02-0.05	7.4-8.4	<2	Low-------	0.10		
52--------------- Hamerly	0-7	0.6-2.0	0.18-0.24	6.6-8.4	<2	Moderate	0.28	5	4L
	7-36	0.6-2.0	0.15-0.19	7.4-8.4	<2	Moderate	0.28		
	36-60	0.2-2.0	0.14-0.19	7.4-8.4	<2	Moderate	0.37		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH	mmhos/cm				
55B*:									
Hecla-----------	0-8	2.0-20	0.10-0.12	6.1-7.8	<2	Low-------	0.17	5	2
	8-29	2.0-20	0.10-0.12	6.1-7.8	<2	Low-------	0.17		
	29-60	2.0-20	0.06-0.10	6.1-7.8	<2	Low-------	0.17		
Ulen------------	0-12	6.0-20	0.16-0.18	7.9-8.4	<4	Low-------	0.17	4	2
	12-24	6.0-20	0.10-0.12	7.9-8.4	<4	Low-------	0.17		
	24-60	6.0-20	0.06-0.08	7.9-8.4	<4	Low-------	0.17		
56B-------------- Maddock	0-16	6.0-20	0.08-0.12	6.6-7.8	<2	Low-------	0.17	5	2
	16-60	6.0-20	0.05-0.13	6.6-8.4	<2	Low-------	0.17		
61, 61B---------- Nutley	0-8	0.06-0.2	0.15-0.18	6.6-8.4	<2	High------	0.28	5	4
	8-60	0.06-0.2	0.13-0.15	7.4-8.4	<2	High------	0.28		
63C*:									
Sioux-----------	0-8	2.0-6.0	0.11-0.15	6.6-8.4	<2	Low-------	0.20	2	3
	8-12	2.0-6.0	0.10-0.15	7.4-8.4	<2	Low-------	0.20		
	12-60	>6.0	0.03-0.06	7.4-8.4	<2	Low-------	0.10		
Arvilla---------	0-16	2.0-6.0	0.13-0.15	6.6-8.4	<2	Low-------	0.20	3	3
	16-60	>6.0	0.02-0.05	7.4-8.4	<2	Low-------	0.10		
63E*:									
Sioux-----------	0-7	2.0-6.0	0.11-0.15	6.6-8.4	<2	Low-------	0.20	2	3
	7-11	2.0-6.0	0.10-0.15	7.4-8.4	<2	Low-------	0.20		
	11-60	>6.0	0.03-0.06	7.4-8.4	<2	Low-------	0.10		
Arvilla---------	0-16	2.0-6.0	0.13-0.15	6.6-8.4	<2	Low-------	0.20	3	3
	16-60	>6.0	0.02-0.05	7.4-8.4	<2	Low-------	0.10		
64B*:									
Renshaw---------	0-8	0.6-2.0	0.18-0.20	6.1-7.8	<2	Low-------	0.28	3	6
	8-17	0.6-6.0	0.11-0.18	6.6-8.4	<2	Low-------	0.28		
	17-60	>6.0	0.03-0.06	6.6-8.4	<2	Low-------	0.10		
Sioux-----------	0-7	0.6-2.0	0.18-0.20	6.6-8.4	<2	Low-------	0.28	2	5
	7-12	2.0-6.0	0.10-0.15	7.4-8.4	<2	Low-------	0.20		
	12-60	>6.0	0.03-0.06	7.4-8.4	<2	Low-------	0.10		
65--------------- Renshaw	0-7	0.6-2.0	0.18-0.20	6.1-7.8	<2	Low-------	0.28	3	6
	7-19	0.6-6.0	0.11-0.18	6.6-8.4	<2	Low-------	0.28		
	19-60	>6.0	0.03-0.06	6.6-8.4	<2	Low-------	0.10		
66C*, 66E*:									
Williams--------	0-5	0.6-2.0	0.17-0.24	6.6-7.3	<2	Low-------	0.28	5	6
	5-13	0.6-2.0	0.16-0.20	6.6-7.8	<2	Moderate	0.28		
	13-60	0.06-0.6	0.15-0.18	7.9-8.4	<2	Moderate	0.37		
Zahl------------	0-6	0.6-2.0	0.17-0.22	6.6-7.8	<2	Moderate	0.28	5	4L
	6-26	0.6-2.0	0.15-0.19	7.4-8.4	<2	Moderate	0.37		
	26-60	0.06-0.6	0.15-0.19	7.4-8.4	<2	Moderate	0.37		
67*, 67B*:									
Williams--------	0-7	0.6-2.0	0.17-0.24	6.6-7.3	<2	Low-------	0.28	5	6
	7-14	0.6-2.0	0.16-0.20	6.6-7.8	<2	Moderate	0.28		
	14-60	0.06-0.6	0.15-0.18	7.9-8.4	<2	Moderate	0.37		
Bowbells--------	0-13	0.6-2.0	0.17-0.24	6.1-7.3	<2	Low-------	0.28	5	6
	13-32	0.6-2.0	0.16-0.22	6.1-7.3	<2	Moderate	0.28		
	32-60	0.06-0.6	0.14-0.18	7.9-8.4	<2	Moderate	0.37		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors		Wind erodibility group
							K	T	
	In	In/hr	In/in	pH	mmhos/cm				
69C*:									
Maddock----------	0-14	6.0-20	0.08-0.12	6.6-7.8	<2	Low--------	0.17	5	2
	14-60	6.0-20	0.05-0.13	6.6-8.4	<2	Low--------	0.17		
Serden-----------	0-4	6.0-20	0.08-0.12	6.1-7.3	<2	Low--------	0.15	5	2
	4-60	6.0-20	0.05-0.07	6.6-7.8	<2	Low--------	0.15		
69E-------------- Serden	0-4	6.0-20	0.08-0.12	6.1-7.3	<2	Low--------	0.15	5	2
	4-60	6.0-20	0.05-0.07	6.6-7.8	<2	Low--------	0.15		
72B-------------- Miranda	0-7	0.6-2.0	0.18-0.20	6.1-7.3	<2	Low--------	0.32	1	6
	7-12	<0.06	0.14-0.18	6.6-8.4	2-8	Moderate	0.32		
	12-60	<0.06	0.13-0.17	7.9-9.0	4-16	Moderate	0.32		
74B*:									
Williams---------	0-7	0.6-2.0	0.17-0.24	6.6-7.3	<2	Low--------	0.28	5	6
	7-14	0.6-2.0	0.16-0.20	6.6-7.8	<2	Moderate	0.28		
	14-60	0.06-0.6	0.15-0.18	7.9-8.4	<2	Moderate	0.37		
Noonan-----------	0-11	0.6-2.0	0.20-0.22	6.1-7.3	<2	Moderate	0.32	3	6
	11-18	0.06-0.2	0.12-0.14	6.6-9.0	<2	High-------	0.32		
	18-60	0.06-0.2	0.10-0.14	7.9-9.0	2-8	Moderate	0.32		
76--------------- Letcher	0-13	0.6-2.0	0.11-0.17	5.1-7.8	<2	Low--------	0.24	3	3
	13-16	0.06-0.2	0.08-0.14	6.6-9.0	2-8	Low--------	0.24		
	16-50	0.6-2.0	0.13-0.20	7.4-9.0	2-8	Low--------	0.24		
	50-60	0.06-0.2	0.13-0.20	7.4-9.0	2-8	High-------	0.24		
92E*:									
Buse-------------	0-7	0.2-2.0	0.17-0.22	6.6-8.4	<2	Moderate	0.28	5	4L
	7-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
Barnes-----------	0-5	0.6-2.0	0.13-0.24	6.1-7.8	<2	Low--------	0.28	5	6
	5-15	0.6-2.0	0.15-0.19	6.1-7.8	<4	Moderate	0.28		
	15-31	0.2-0.6	0.14-0.19	7.4-8.4	<4	Moderate	0.37		
	31-60	0.2-0.6	0.14-0.19	7.4-8.4	<8	Moderate	0.37		
93E*:									
Vebar------------	0-5	2.0-6.0	0.15-0.17	6.1-7.8	<2	Low--------	0.20	4	3
	5-31	2.0-6.0	0.15-0.17	6.1-8.4	<2	Low--------	0.20		
	31-60	---	---	---	---	-----------	----		
Williams---------	0-6	0.6-2.0	0.17-0.24	6.6-7.3	<2	Low--------	0.28	5	6
	6-13	0.6-2.0	0.16-0.20	6.6-7.8	<2	Moderate	0.28		
	13-60	0.06-0.6	0.15-0.18	7.9-8.4	<2	Moderate	0.37		

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--SOIL AND WATER FEATURES

["Flooding" and "water table" and terms such as "occasional," "long," "apparent," and "perched" are explained in the text. The symbol < means less than; > means more than. Absence of an entry indicates that the feature is not a concern or that data were not estimated]

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months		Uncoated steel	Concrete
					Ft					
2 Arveson	B/D	None	---	---	+1-1.0	Apparent	Jan-Dec	High	High	Low.
3 Marysland	B/D	None	---	---	1.0-2.5	Apparent	Nov-Jul	High	High	Low.
5 Harriet	D	Occasional	Long	Apr-Jun	0-1.0	Apparent	Sep-Jun	High	High	Moderate.
7*:										
Arveson	B/D	None	---	---	1.0-2.0	Apparent	Apr-Jul	High	High	Low.
Ulen	B	None	---	---	2.5-6.0	Apparent	Apr-Jul	Moderate	Low	Low.
10*:										
Minnewaukan	A/D	None	---	---	0-2.5	Apparent	Apr-Jun	Moderate	High	Low.
Stirum	B/D	None	---	---	+.5-1.0	Apparent	Apr-Jul	Moderate	High	Moderate.
14 Tonka	C/D	None	---	---	+.5-1.0	Apparent	Apr-Jun	High	High	Low.
15 Parnell	C/D	None	---	---	+2-2.0	Apparent	Jan-Dec	High	High	Low.
16 Southam	D	None	---	---	+5-1.0	Apparent	Jan-Dec	High	High	Low.
17 Markey	A/D	None	---	---	+1-1.0	Apparent	Nov-Jun	High	High	Low.
19 Colvin	C	None	---	---	0-2.0	Apparent	Apr-Jul	High	High	Moderate.
20 Colvin	C/D	None	---	---	+1-1.0	Apparent	Jan-Dec	High	High	Low.
21D Buse	B	None	---	---	>6.0	---	---	Moderate	Low	Low.
22B*:										
Barnes	B	None	---	---	>6.0	---	---	Moderate	High	Low.
Svea	B	None	---	---	4.0-6.0	Apparent	Apr-Jun	Moderate	High	Low.
22C*:										
Barnes	B	None	---	---	>6.0	---	---	Moderate	High	Low.
Buse	B	None	---	---	>6.0	---	---	Moderate	Low	Low.
24B*:										
Cresbard	C	None	---	---	>6.0	---	---	Moderate	High	Moderate.
Barnes	B	None	---	---	>6.0	---	---	Moderate	High	Low.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months		Uncoated steel	Concrete
					Ft					
28D*:										
Buse	B	None	---	---	>6.0	---	---	Moderate	Low	Low.
Svea	B	None	---	---	4.0-6.0	Apparent	Apr-Jun	Moderate	High	Low.
29E*:										
Barnes	B	None	---	---	>6.0	---	---	Moderate	High	Low.
Buse	B	None	---	---	>6.0	---	---	Moderate	Low	Low.
Parnell	C/D	None	---	---	+2-2.0	Apparent	Jan-Dec	High	High	Low.
32 Overly	C	None	---	---	4.0-6.0	Apparent	Apr-Jun	High	High	Low.
35B*:										
Towner	B	None	---	---	3.0-6.0	Perched	Apr-Jun	Moderate	High	Low.
Embden	B	None	---	---	4.0-6.0	Apparent	Apr-Jun	Moderate	High	Low.
35C*:										
Towner	B	None	---	---	3.0-6.0	Perched	Apr-Jun	Moderate	High	Low.
Barnes	B	None	---	---	>6.0	---	---	Moderate	High	Low.
36B Flaxton	B	None	---	---	>6.0	---	---	Moderate	High	Low.
37 Divide	B	None	---	---	2.5-5.0	Apparent	Apr-Jun	Moderate	High	Low.
38D*:										
Flaxton	B	None	---	---	>6.0	---	---	Moderate	High	Low.
Zahl	B	None	---	---	>6.0	---	---	Moderate	Moderate	Low.
39 Embden	B	None	---	---	4.0-6.0	Apparent	Apr-Jun	Moderate	High	Low.
42B*:										
Barnes	B	None	---	---	>6.0	---	---	Moderate	High	Low.
Sioux	A	None	---	---	>6.0	---	---	Low	Low	Low.
44 Fordville	B	None	---	---	>6.0	---	---	Low	Moderate	Low.
49B, 49C, 49D Arvilla	A	None	---	---	>6.0	---	---	Low	Moderate	Low.
52 Hamerly	C	None	---	---	2.0-4.0	Apparent	Apr-Jun	High	High	Low.
55B*:										
Hecla	A	None	---	---	3.0-6.0	Apparent	Apr-Oct	Moderate	Moderate	Low.
Ulen	B	None	---	---	2.5-6.0	Apparent	Apr-Jul	Moderate	Low	Low.
56B Maddock	A	None	---	---	>6.0	---	---	Low	Moderate	Low.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months		Uncoated steel	Concrete
					Ft					
61, 61B----------- Nutley	C	None--------	---	---	>6.0	---	---	Moderate	High-----	Low.
63C*, 63E*:										
Sioux------------	A	None--------	---	---	>6.0	---	---	Low------	Low------	Low.
Arvilla----------	A	None--------	---	---	>6.0	---	---	Low------	Moderate	Low.
64B*:										
Renshaw----------	B	None--------	---	---	>6.0	---	---	Low------	Moderate	Low.
Sioux------------	A	None--------	---	---	>6.0	---	---	Low------	Low------	Low.
65--------------- Renshaw	B	None--------	---	---	>6.0	---	---	Low------	Moderate	Low.
66C*, 66E*:										
Williams---------	B	None--------	---	---	>6.0	---	---	Moderate	High-----	Low.
Zahl-------------	B	None--------	---	---	>6.0	---	---	Moderate	Moderate	Low.
67*, 67B*:										
Williams---------	B	None--------	---	---	>6.0	---	---	Moderate	High-----	Low.
Bowbells---------	B	None--------	---	---	>6.0	---	---	Moderate	High-----	Low.
69C*:										
Maddock----------	A	None--------	---	---	>6.0	---	---	Low------	Moderate	Low.
Serden-----------	A	None--------	---	---	>6.0	---	---	Low------	Moderate	Low.
69E-------------- Serden	A	None--------	---	---	>6.0	---	---	Low------	Moderate	Low.
72B-------------- Miranda	D	None--------	---	---	>6.0	---	---	Moderate	High-----	Moderate.
74B*:										
Williams---------	B	None--------	---	---	>6.0	---	---	Moderate	High-----	Low.
Noonan-----------	D	None--------	---	---	>6.0	---	---	Moderate	High-----	Moderate.
76--------------- Letcher	D	None--------	---	---	3.5-6.0	Perched	Nov-Jun	Moderate	High-----	Moderate.
92E*:										
Buse-------------	B	None--------	---	---	>6.0	---	---	Moderate	Low------	Low.
Barnes-----------	B	None--------	---	---	>6.0	---	---	Moderate	High-----	Low.
93E*:										
Vebar------------	B	None--------	---	---	>6.0	---	---	Low------	Moderate	Low.
Williams---------	B	None--------	---	---	>6.0	---	---	Moderate	High-----	Low.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--ENGINEERING INDEX TEST DATA

[Dashes indicate data were not available. LL means liquid limit; PI, plasticity index; MD, maximum dry density; OM, optimum moisture; and NP, nonplastic]

Soil name, report number, horizon, and depth in inches	Classification		Grain-size distribution								LL	PI	Moisture density	
			Percentage passing sieve--					Percentage smaller than--						
	AASHTO	Unified	3/8 inch	No. 4	No. 10	No. 40	No. 200	.02 mm	.005 mm	.002 mm			MD	OM
											Pct		Lb/ft3	Pct
Arvilla sandy loam: (S81ND-043-166)														
Bw------ 10 to 16	A-2-4(0)	SM-SC	100	100	100	74	22	---	4	---	25	6	128	10
2C------ 16 to 60	A-3(0)	SP-SM	100	100	100	56	9	---	2	---	---	NP	123	12
Flaxton fine sandy loam: (S81ND-043-171)														
Bw------ 6 to 21	A-2-4(0)	SM	100	100	100	93	28	---	10	---	---	NP	116	14
2Bk----- 27 to 46	A-6(8)	ML	93	87	83	77	60	---	33	---	37	17	112	15
Fordville loam: (S81ND-043-174)														
Bw------ 9 to 23	A-6(4)	SC	98	98	97	78	50	---	14	---	34	13	122	12
2C------ 33 to 60	A-1-6(0)	SW-SM	89	81	65	43	8	---	1	---	---	NP	124	11
Maddock loamy fine sand: (S81ND-043-165)														
C1------ 18 to 29	A-2-4(0)	SM	100	98	96	85	13	---	6	---	---	NP	125	11
C2------ 29 to 60	A-2-4(0)	SM	100	100	100	96	18	---	6	---	---	NP	118	14
Marysland loam: (S80ND-043-001)														
Bkg2---- 14 to 25	A-6(6)	CL	100	99	97	75	52	---	28	---	37	19	120	13
2Cg3---- 45 to 55	A-1-b(0)	SP-SM	98	92	77	41	11	---	3	---	---	NP	127	10
Minnewaukan sandy loam: (S80ND-043-002)														
Cg2----- 12 to 24	A-2-4(0)	SM	100	100	99	97	17	---	6	---	---	NP	115	15
Cg3----- 24 to 45	A-2-4(0)	SM	100	100	99	95	14	---	4	---	---	NP	119	13
Parnell silty clay loam: (S80ND-043-003)														
Bt2----- 18 to 29	A-7-6(19)	CH	100	100	100	100	98	---	56	---	55	31	101	20
C------- 42 to 60	A-7-6(20)	CH	100	100	100	100	97	---	58	---	58	32	102	20

TABLE 17.--ENGINEERING INDEX TEST DATA--Continued

Soil name, report number, horizon, and depth in inches	Classification		Grain-size distribution								LL	PI	Moisture density	
			Percentage passing sieve--					Percentage smaller than--						
	AASHTO	Unified	3/8 inch	No. 4	No. 10	No. 40	No. 200	.02 mm	.005 mm	.002 mm			MD	OM
											Pct		Lb/ft3	Pct
Southam silty clay loam: (S80ND-043-004)														
Ag2----- 18 to 28	A-7-6(14)	CL	100	100	100	99	88	---	40	---	45	23	107	17
Cg2----- 38 to 60	A-7-6(18)	CL	100	100	99	96	83	---	47	---	49	31	112	15
Towner loamy fine sand: (S81ND-043-173)														
Bw------ 16 to 26	A-3(0)	SP-SM	100	100	100	78	8	---	2	---	---	NP	117	14
2Bk----- 30 to 51	A-6(5)	CL	99	97	93	85	57	---	29	---	32	13	118	14

TABLE 18.--CLASSIFICATION OF THE SOILS

[An asterisk in the first column indicates that the soil is a taxadjunct to the series. See text for a description of those characteristics of the soil that are outside the range of the series]

Soil name	Family or higher taxonomic class
Arveson	Coarse-loamy, frigid Typic Calciaquolls
*Arvilla	Sandy, mixed Udic Haploborolls
Barnes	Fine-loamy, mixed Udic Haploborolls
*Bowbells	Fine-loamy, mixed Pachic Argiborolls
Buse	Fine-loamy, mixed Udorthentic Haploborolls
Colvin	Fine-silty, frigid Typic Calciaquolls
Cresbard	Fine, montmorillonitic Glossic Udic Natriborolls
Divide	Fine-loamy over sandy or sandy-skeletal, frigid Aeric Calciaquolls
Embden	Coarse-loamy, mixed Pachic Udic Haploborolls
*Flaxton	Fine-loamy, mixed Pachic Argiborolls
Fordville	Fine-loamy over sandy or sandy-skeletal, mixed Pachic Udic Haploborolls
Hamerly	Fine-loamy, frigid Aeric Calciaquolls
Harriet	Fine, montmorillonitic, frigid Typic Natraquolls
Hecla	Sandy, mixed Aquic Haploborolls
Letcher	Coarse-loamy, mixed Udic Natriborolls
Maddock	Sandy, mixed Udorthentic Haploborolls
*Markey	Sandy or sandy-skeletal, mixed, euic Terric Borosaprists
*Marysland	Fine-loamy over sandy or sandy-skeletal, frigid Typic Calciaquolls
Minnewaukan	Mixed, frigid Typic Psammaquents
Miranda	Fine-loamy, mixed Leptic Natriborolls
Noonan	Fine-loamy, mixed Typic Natriborolls
Nutley	Fine, montmorillonitic Udertic Haploborolls
Overly	Fine-silty, mixed Pachic Udic Haploborolls
Parnell	Fine, montmorillonitic, frigid Typic Argiaquolls
Renshaw	Fine-loamy over sandy or sandy-skeletal, mixed Udic Haploborolls
Serden	Mixed, frigid Typic Udipsamments
Sioux	Sandy-skeletal, mixed Udorthentic Haploborolls
*Southam	Fine, montmorillonitic (calcareous), frigid Cumulic Haplaquolls
Stirum	Coarse-loamy, mixed, frigid Typic Natraquolls
Svea	Fine-loamy, mixed Pachic Udic Haploborolls
Tonka	Fine, montmorillonitic, frigid Argiaquic Argialbolls
Towner	Sandy over loamy, mixed Udorthentic Haploborolls
Ulen	Sandy, frigid Aeric Calciaquolls
Vebar	Coarse-loamy, mixed Typic Haploborolls
Williams	Fine-loamy, mixed Typic Argiborolls
Zahl	Fine-loamy, mixed Entic Haploborolls

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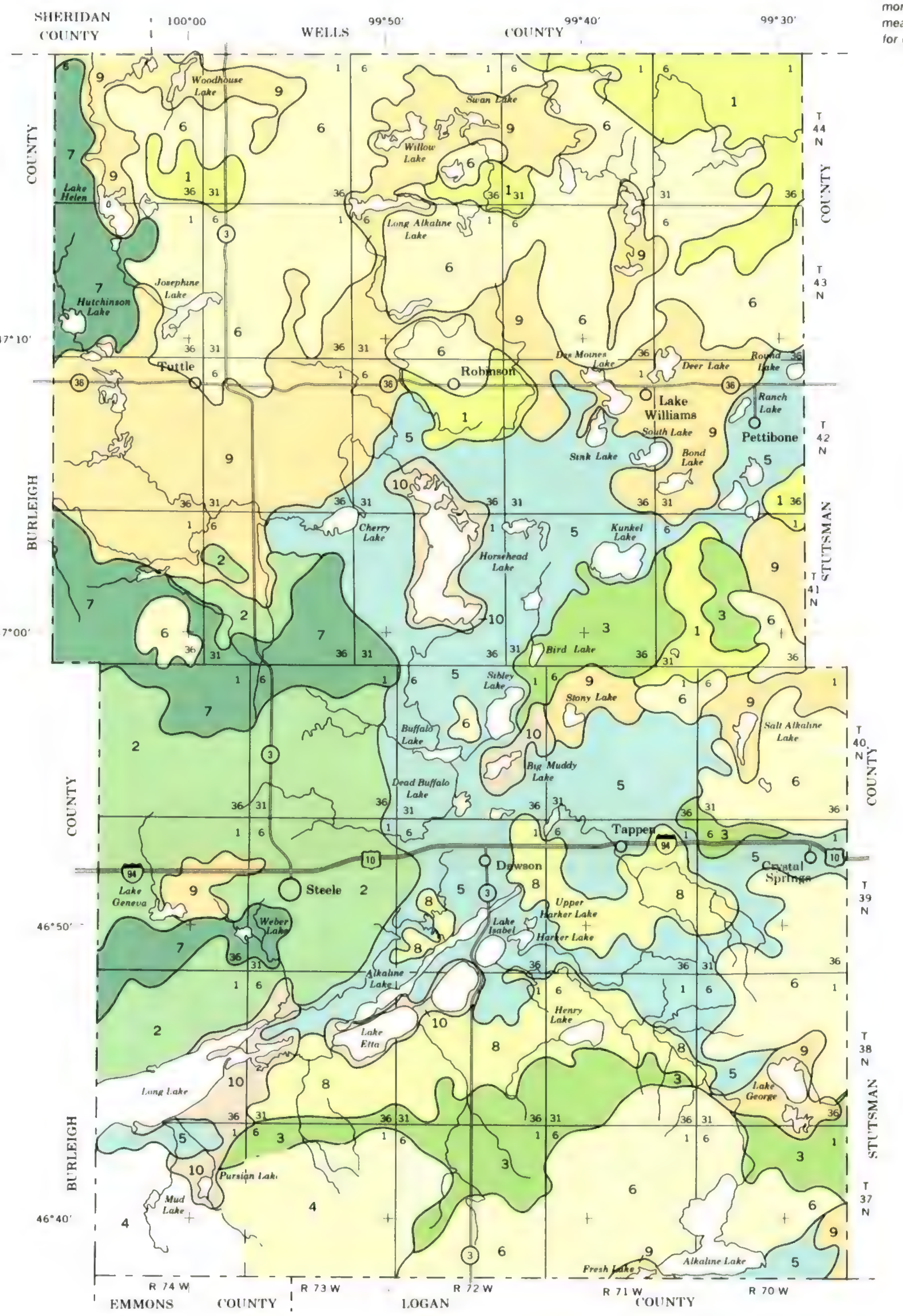
Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.



SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

N

LEGEND*

NEARLY LEVEL TO GENTLY ROLLING, MEDIUM TEXTURED SOILS ON GLACIAL TILL PLAINS

1 — Barnes Svea Buse association Deep medium textured, nearly level to gently rolling, well drained and moderately well drained soils formed in glacial till

2 — Williams Bowbells association Deep, medium textured, nearly level and undulating well drained and moderately well drained soils formed in glacial till

NEARLY LEVEL TO ROLLING, COARSE TEXTURED TO MEDIUM TEXTURED SOILS ON GLACIAL TILL PLAINS AND MORAINES

3 — Barnes Towner Maddock association Deep medium textured to coarse textured, nearly level to gently rolling, well drained and moderately well drained soils formed in glacial till and eolian sediments

4 — Flaxton Williams association Deep, medium textured and moderately coarse textured nearly level to rolling, well drained soils formed in glacial till and eolian sediments

NEARLY LEVEL TO ROLLING, MODERATELY COARSE TEXTURED SOILS ON GLACIAL OUTWASH PLAINS

5 — Arvilla association Deep moderately coarse textured nearly level to rolling, somewhat excessively drained soils formed in glacial outwash

LEVEL TO STEEP, MEDIUM TEXTURED AND MODERATELY FINE TEXTURED SOILS ON GLACIAL TILL PLAINS AND MORAINES

6 — Barnes Buse Parnell association Deep, medium textured and moderately fine textured, level to steep, well drained and very poorly drained soils formed in glacial till and alluvium

7 — Williams Zahl association Deep, medium textured, gently rolling to steep, well drained soils formed in glacial till

LEVEL TO STEEP, COARSE TEXTURED TO MEDIUM TEXTURED SOILS ON COALESCED AND COLLAPSED GLACIAL OUTWASH PLAINS

8 — Maddock Hecla Serden association Deep, coarse textured, nearly level to steep, well drained, moderately well drained, and excessively drained soils formed in glacial outwash and eolian sediments

9 — Sioux Arvilla Renshaw association Deep, medium textured and moderately coarse textured, level to steep, excessively drained and somewhat excessively drained soils formed in glacial outwash

LEVEL, MEDIUM TEXTURED TO COARSE TEXTURED SOILS ON GLACIAL OUTWASH PLAINS AND LAKE PLAINS

10 — Harriet Minnewaukan Stirum association Deep, medium textured to coarse textured, level poorly drained soils formed in glacial outwash and lacustrine sediments

*The texture terms in the descriptive headings refer to the surface layer of the major soils in each association

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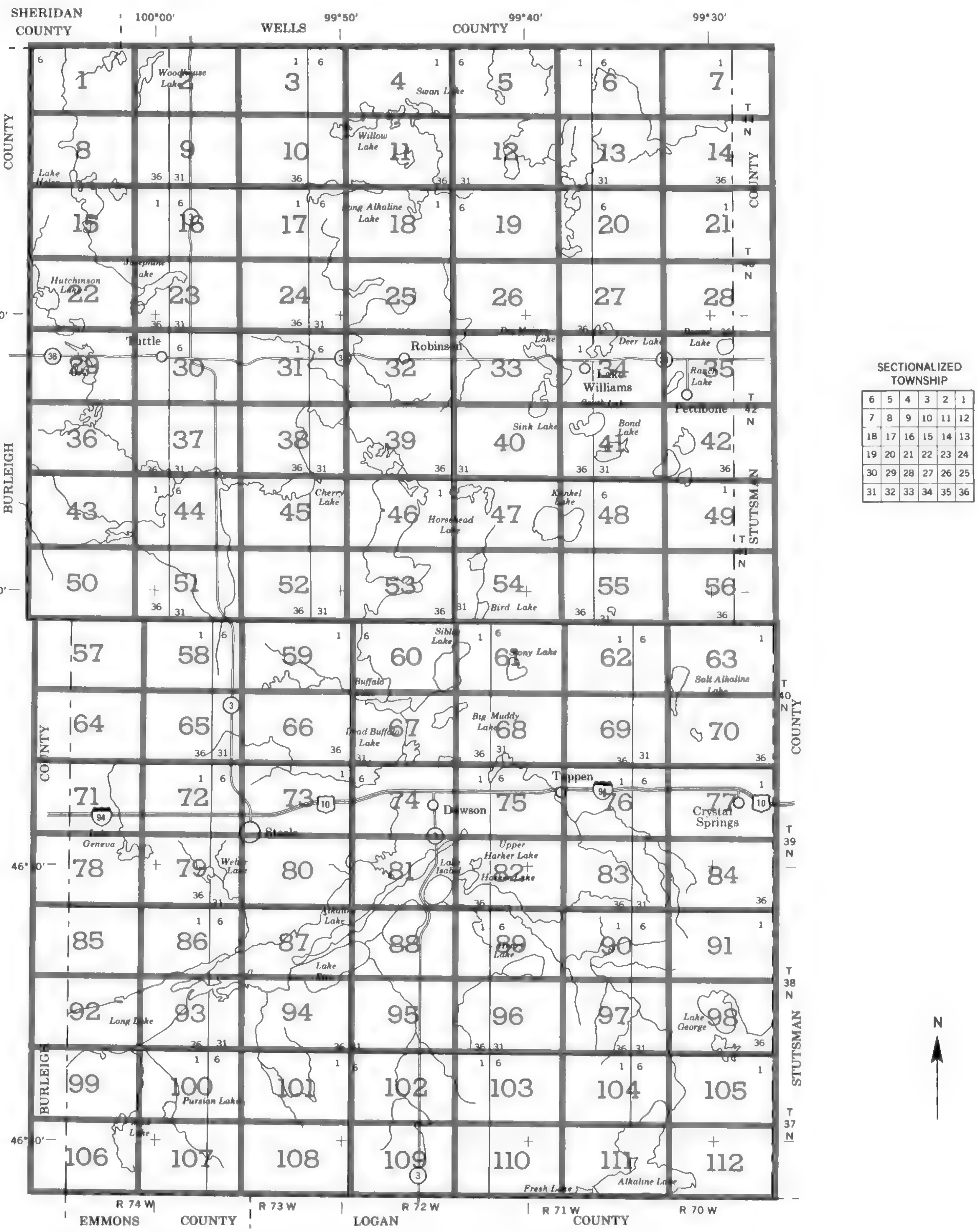
UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
NORTH DAKOTA AGRICULTURAL EXPERIMENT STATION
NORTH DAKOTA COOPERATIVE EXTENSION SERVICE
NORTH DAKOTA STATE SOIL CONSERVATION COMMITTEE

GENERAL SOIL MAP
KIDDER COUNTY, NORTH DAKOTA

Scale 1:316,800

1 0 1 2 3 4 5 Miles

1 0 5 10 Km



INDEX TO MAP SHEETS

KIDDER COUNTY, NORTH DAKOTA

Scale 1:316,800

1 0 1 2 3 4 5 Miles

1 0 5 10 Km

SOIL LEGEND

Map symbols consist of numbers or a combination of numbers and a letter. The initial numbers represent the kind of soil. A capital letter following these numbers indicates the class of slope. Symbols without a slope letter are for nearly level soils.

SYMBOL	NAME
2	Arveson loam, wet
3	Marysland loam
5	Harriet silt loam
7	Arveson-Ulen complex, 0 to 3 percent slopes
10	Minnewaukan and Stirum soils
14	Tonka loam
15	Parnell silty clay loam
16	Southam silty clay loam
17	Markey muck
19	Colvin silt loam, saline
20	Colvin silt loam
21D	Buse loam, 9 to 15 percent slopes
22B	Barnes-Svea loams, 1 to 6 percent slopes
22C	Barnes-Buse loams, 6 to 9 percent slopes
24B	Cresbard-Barnes loams, 1 to 6 percent slopes
28D	Buse-Svea loams, 3 to 15 percent slopes
29E	Barnes-Buse-Parnell complex, 0 to 35 percent slopes
32	Overly silt loam, 0 to 3 percent slopes
35B	Towner-Embden, loamy substratum complex, 1 to 6 percent slopes
35C	Towner-Barnes complex, 6 to 9 percent slopes
36B	Flaxton fine sandy loam, 1 to 6 percent slopes
37	Divide loam, 0 to 3 percent slopes
38D	Flaxton-Zahl complex, 6 to 12 percent slopes
39	Embden fine sandy loam, 1 to 3 percent slopes
42B	Barnes-Sioux sandy loams, 3 to 9 percent slopes
44	Fordville loam, 0 to 3 percent slopes
49B	Arvilla sandy loam, 1 to 6 percent slopes
49C	Arvilla sandy loam, 6 to 9 percent slopes
49D	Arvilla sandy loam, 9 to 15 percent slopes
52	Hamerly loam, 0 to 3 percent slopes
55B	Hecla-Ulen loamy fine sands, 1 to 6 percent slopes
56B	Maddock loamy fine sand, 1 to 6 percent slopes
61	Nutley silty clay, 1 to 3 percent slopes
61B	Nutley silty clay, 3 to 6 percent slopes
63C	Sioux-Arvilla sandy loams, 1 to 9 percent slopes
63E	Sioux-Arvilla sandy loams, 9 to 35 percent slopes
64B	Renshaw-Sioux loams, 1 to 6 percent slopes
65	Renshaw loam, 0 to 3 percent slopes
66C	Williams-Zahl loams, 6 to 9 percent slopes
66E	Williams-Zahl loams, 9 to 35 percent slopes
67	Williams-Bowbells loams, 1 to 3 percent slopes
67B	Williams-Bowbells loams, 3 to 6 percent slopes
69C	Maddock-Serden loamy fine sands, 3 to 9 percent slopes
69E	Serden loamy fine sand, 3 to 35 percent slopes
72B	Miranda loam, 0 to 6 percent slopes
74B	Williams-Noonan loams, 1 to 6 percent slopes
76	Letcher fine sandy loam, 0 to 3 percent slopes
92E	Buse-Barnes loams, 9 to 35 percent slopes
93E	Vebar-Williams complex, 9 to 35 percent slopes

CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES

- National, state or province
- County or parish
- Minor civil division
- Reservation (national forest or park, state forest or park, and large airport)
- Land grant
- Limit of soil survey (label)
- Field sheet matchline & neatline

AD HOC BOUNDARY (label)

- Small airport, airfield, park, oilfield, cemetery, or flood pool

STATE COORDINATE TICK

LAND DIVISION CORNERS (sections and land grants)

ROADS

- Divided (median shown if scale permits)
- Other roads
- Trail

ROAD EMBLEM & DESIGNATIONS

- Interstate
- Federal
- State
- County, farm or ranch

RAILROAD

POWER TRANSMISSION LINE (normally not shown)

PIPE LINE (normally not shown)

FENCE (normally not shown)

LEVEES

- Without road
- With road
- With railroad

DAMS

- Large (to scale)
- Medium or small

PITS

- Gravel pit
- Mine or quarry

MISCELLANEOUS CULTURAL FEATURES

- Farmstead, house (omit in urban areas)
- Church
- School
- Indian mound (label)
- Located object (label)
- Tank (label)
- Wells, oil or gas
- Windmill
- Kitchen midden

WATER FEATURES

DRAINAGE

- Perennial, double line
- Perennial, single line
- Intermittent
- Drainage end
- Canals or ditches
  - Double-line (label)
  - Drainage and/or irrigation

LAKES, PONDS AND RESERVOIRS

- Perennial
- Intermittent

MISCELLANEOUS WATER FEATURES

- Marsh or swamp
- Spring
- Well, artesian
- Well, irrigation
- Wet spot

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS

ESCARPMENTS

- Bedrock (points down slope)
- Other than bedrock (points down slope)

SHORT STEEP SLOPE

GULLY

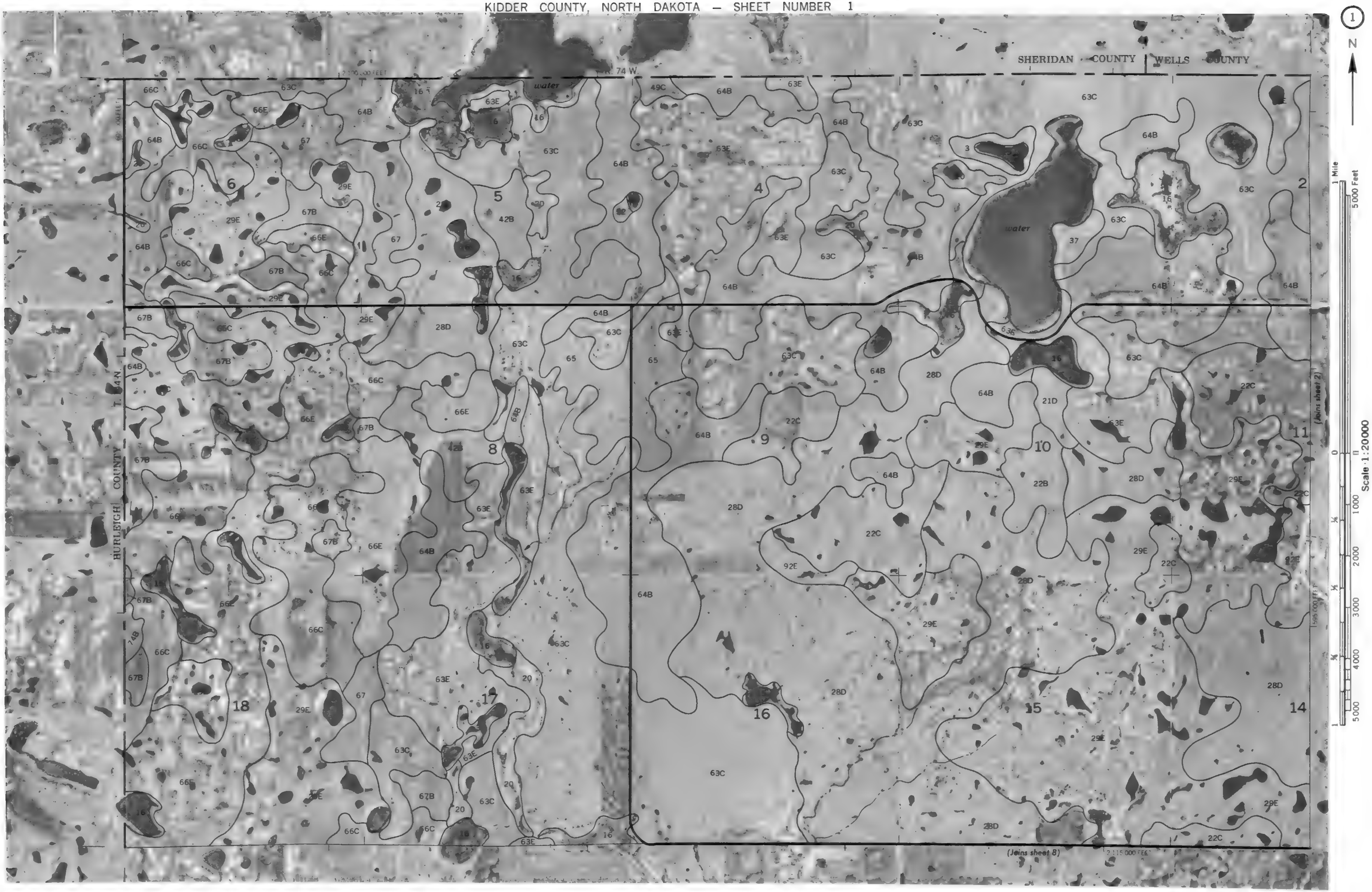
DEPRESSION OR SINK

SOIL SAMPLE SITE (normally not shown)

MISCELLANEOUS

- Blowout
- Clay spot
- Gravelly spot
- Gumbo, slick or scabby spot (sodic)
- Dumps and other similar non soil areas
- Prominent hill or peak
- Rock outcrop (includes sandstone and shale)
- Saline spot
- Sandy spot
- Severely eroded spot
- Slide or slip (tips point upslope)
- Stony spot, very stony spot

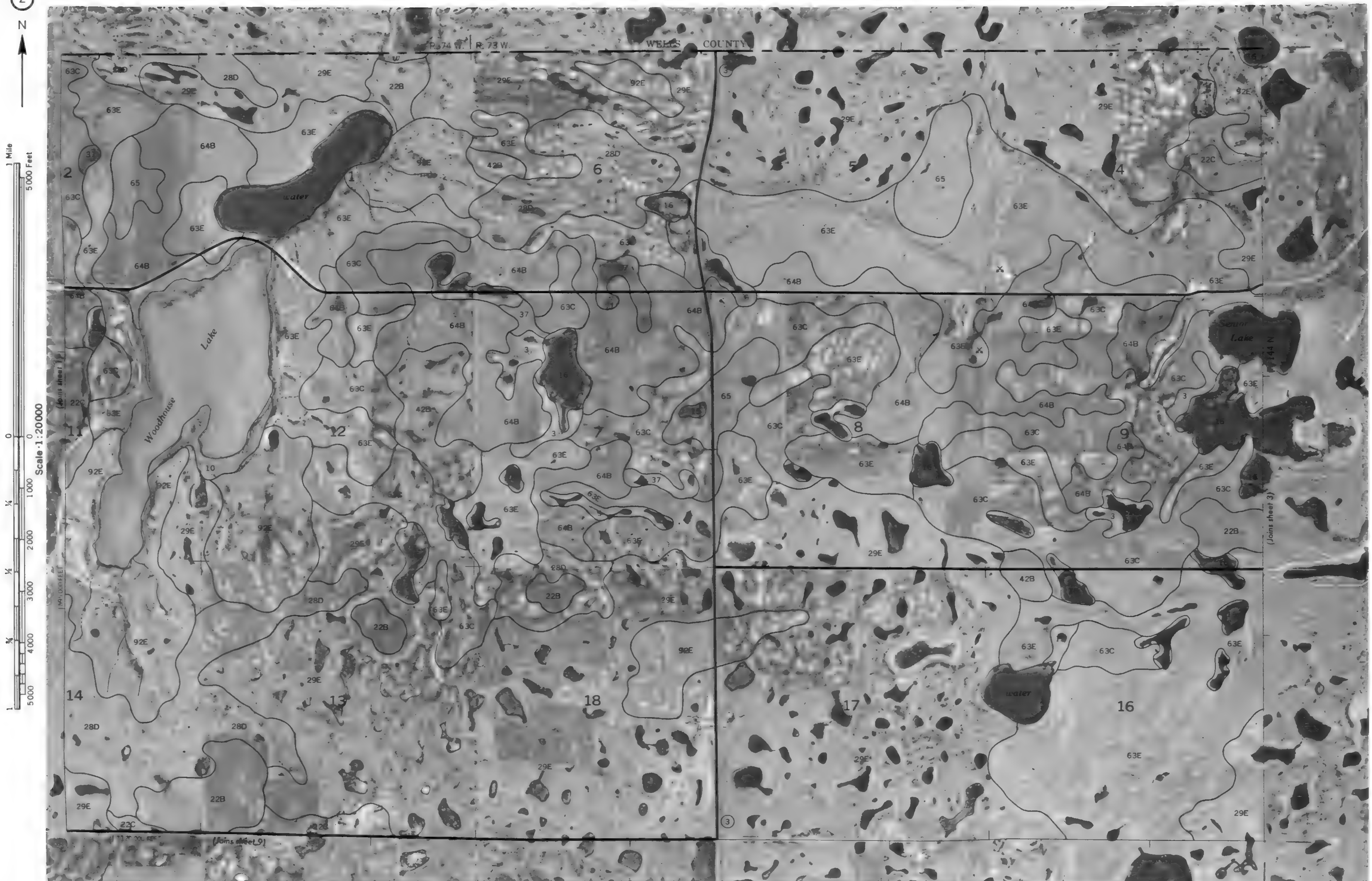
KIDDER COUNTY, NORTH DAKOTA — SHEET NUMBER 1



KIDDER COUNTY, NORTH DAKOTA NO. 1

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

2



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Coordinate grid ticks and land division corners, if shown, are approximately positioned

KIDDER COUNTY, NORTH DAKOTA NO. 2

KIDDER COUNTY, NORTH DAKOTA NO. 3

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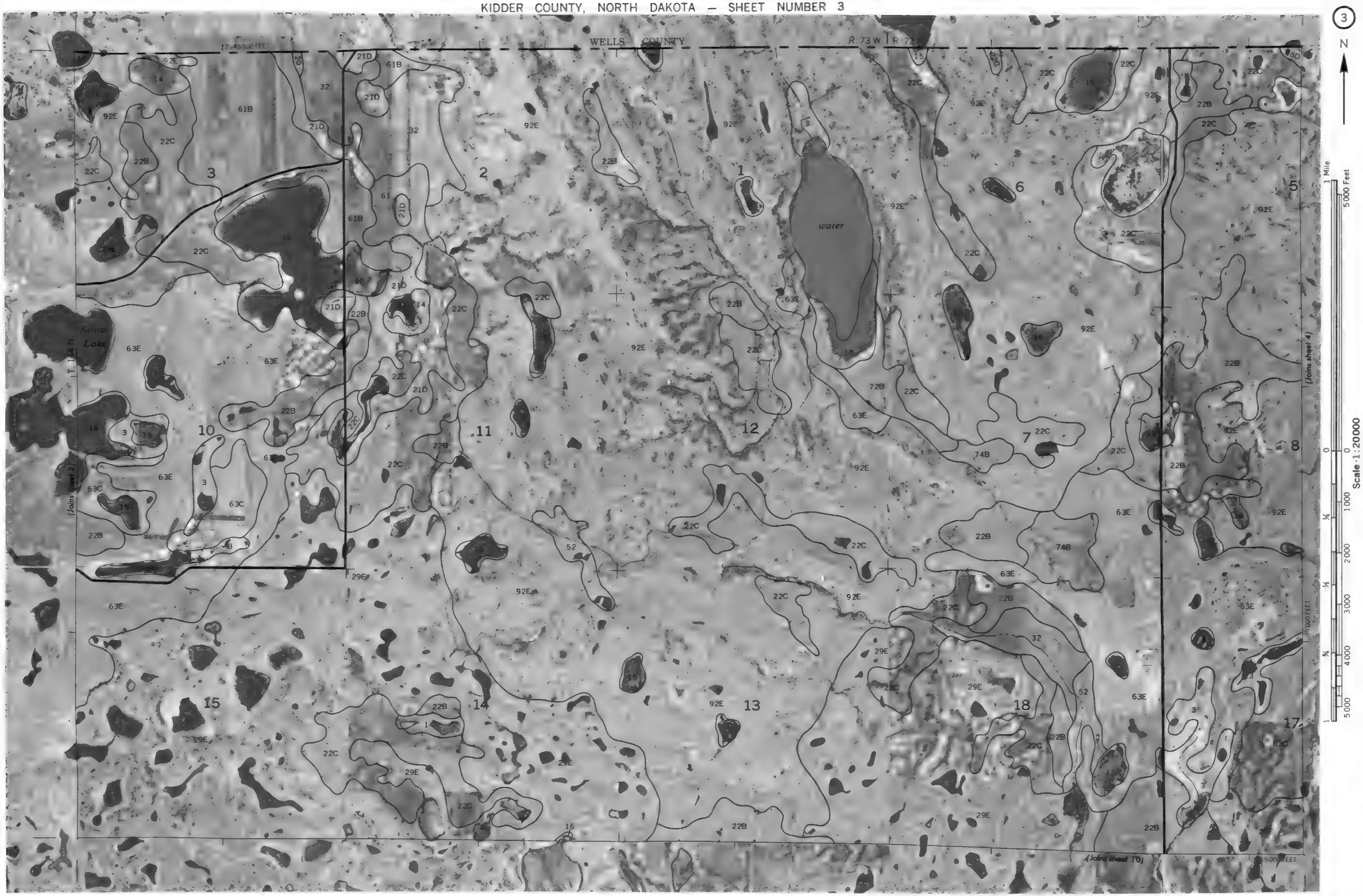
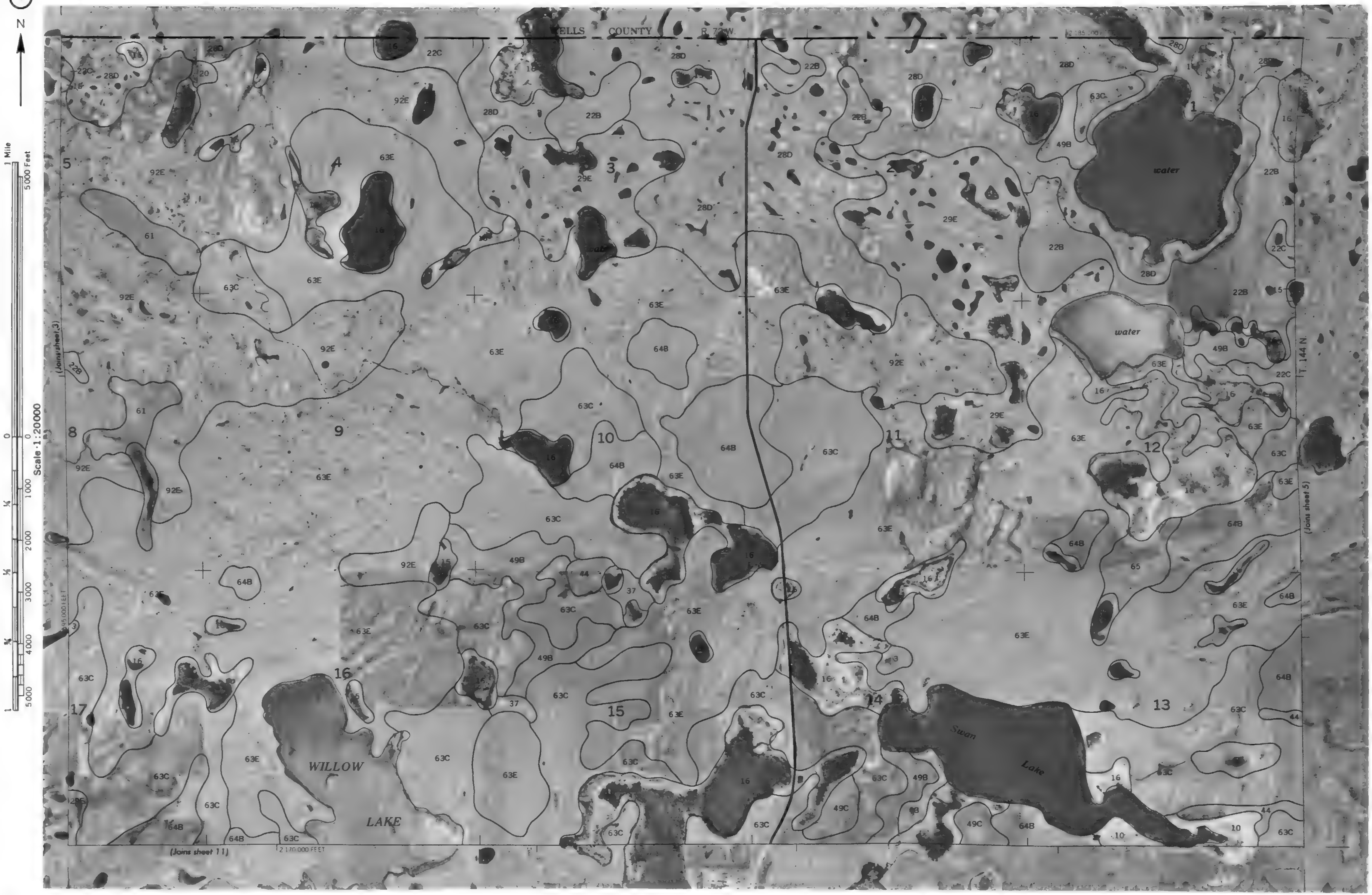
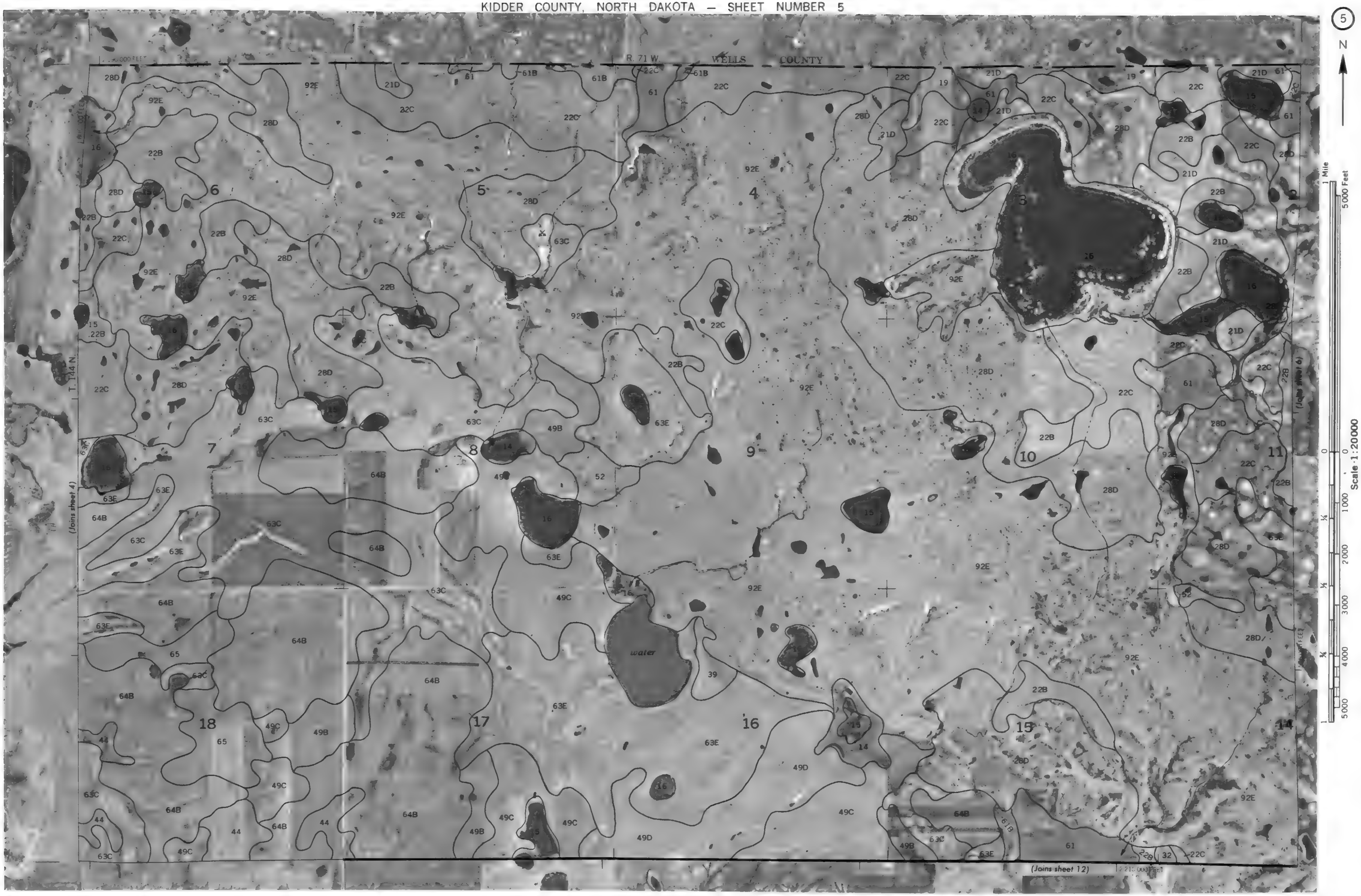




This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

KIDDER COUNTY, NORTH DAKOTA NO. 5

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



6

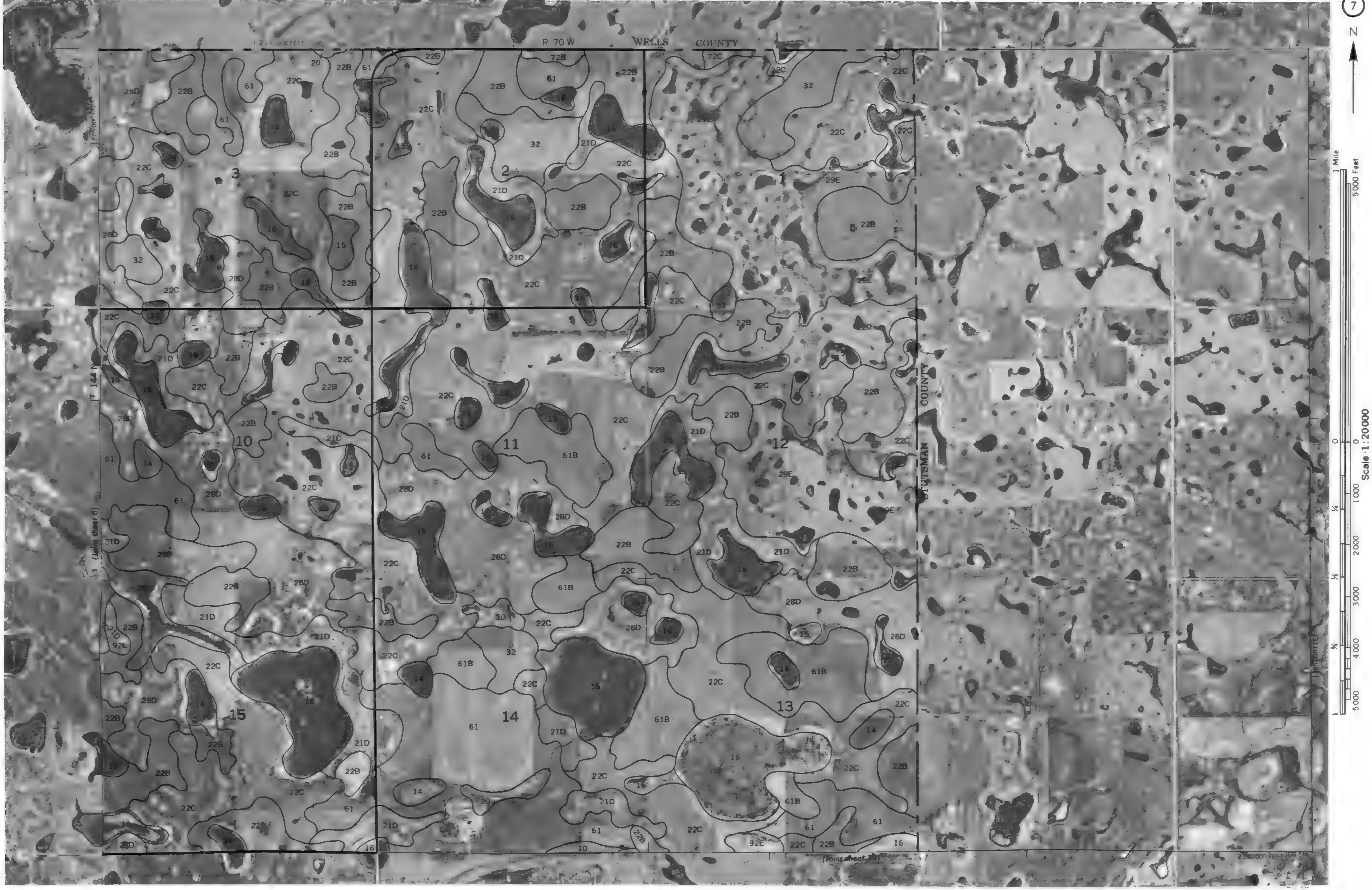
N

1 Mile

5000 Feet

Scale 1:20000

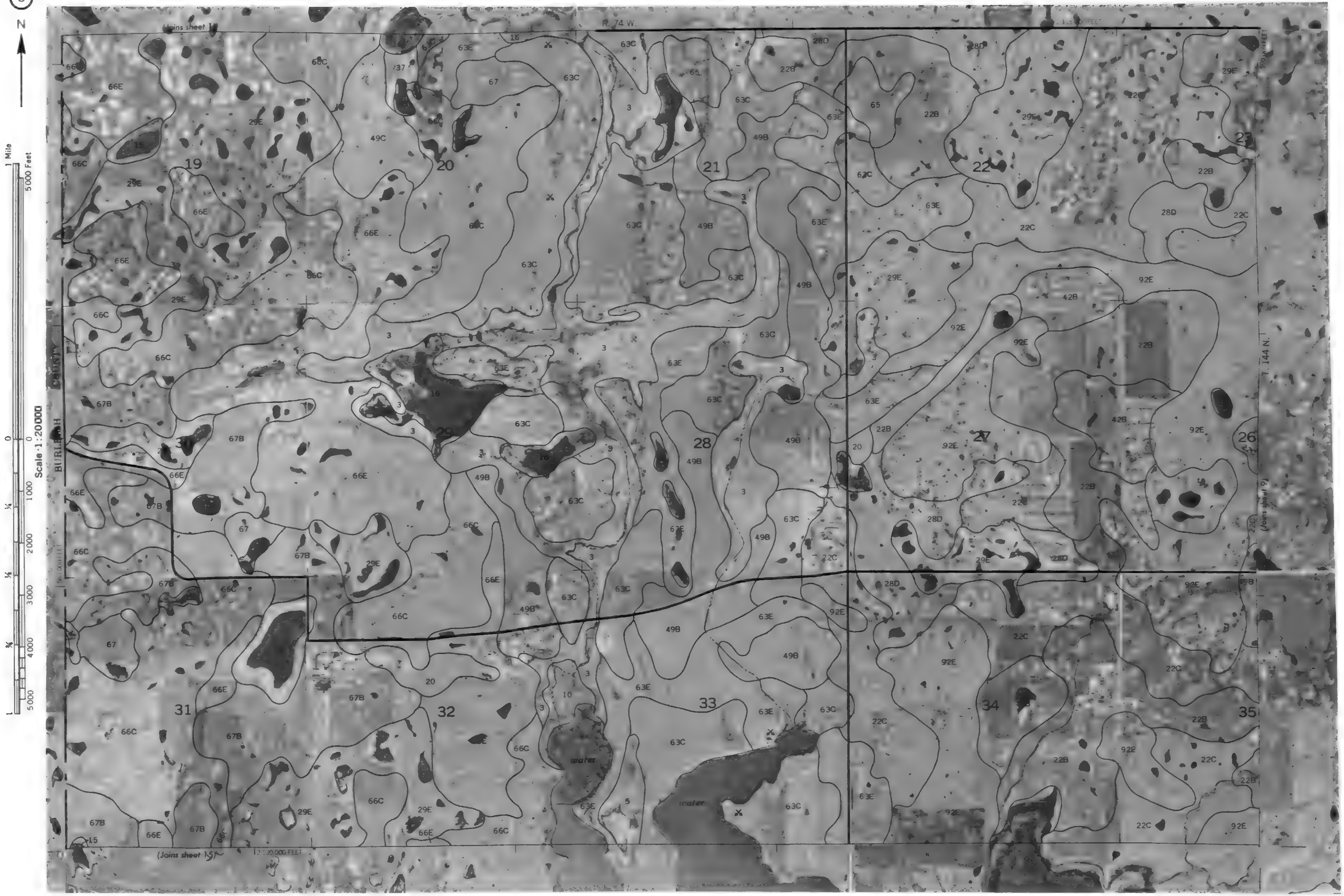
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



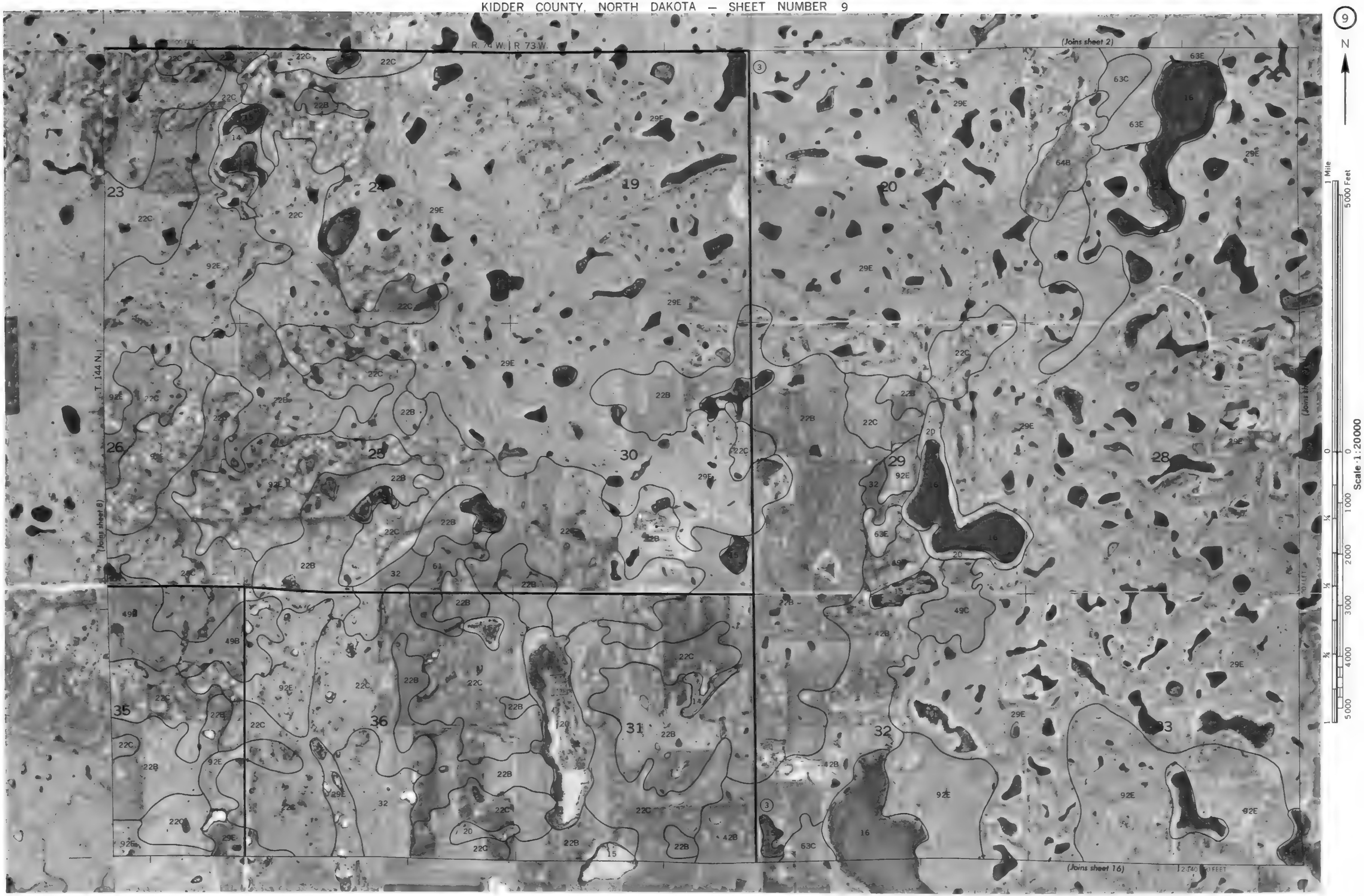
KIDDER COUNTY, NORTH DAKOTA NO. 7

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

8

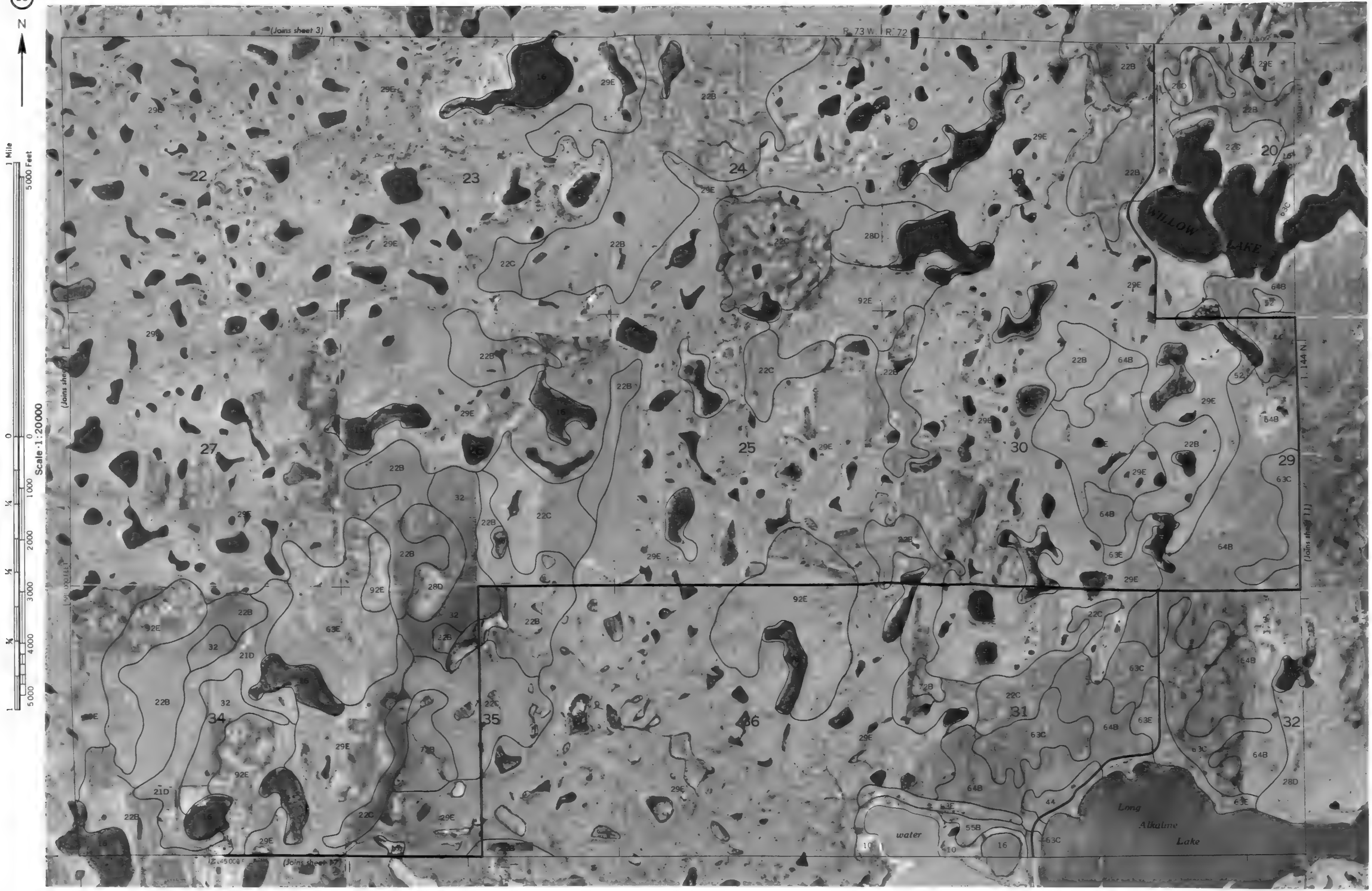


This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



KIDDER COUNTY, NORTH DAKOTA NO. 9

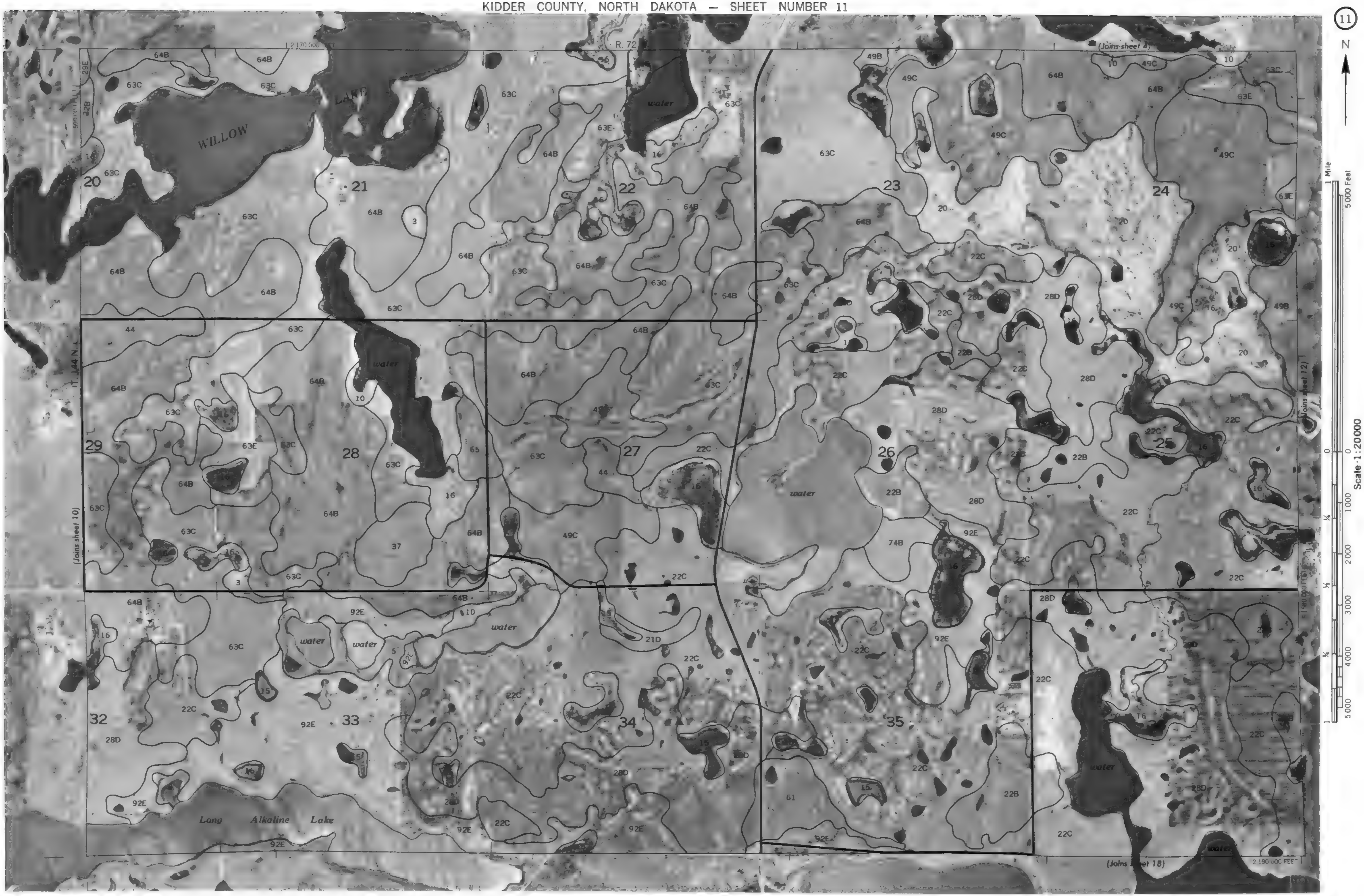
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned



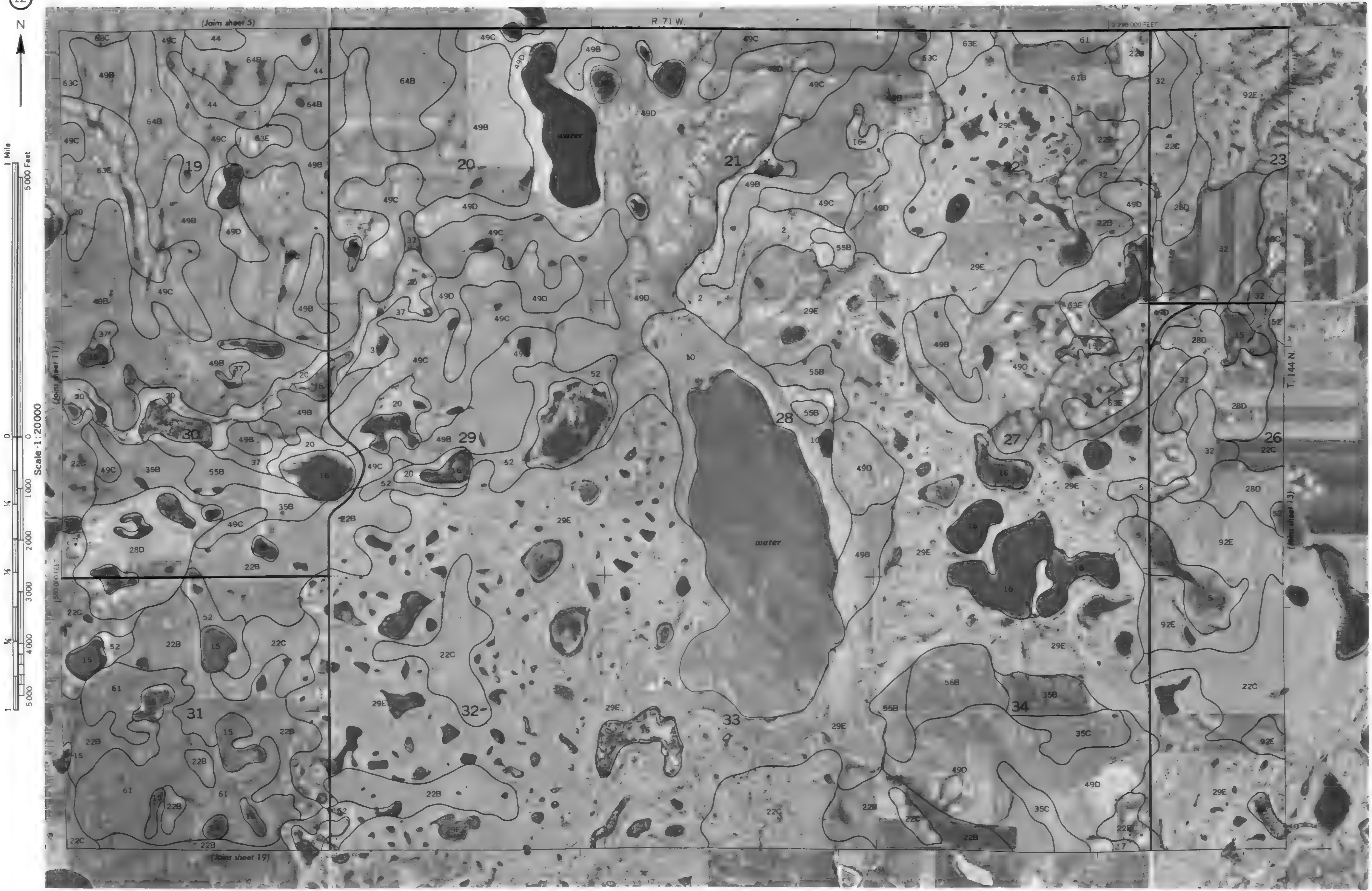
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

KIDDER COUNTY, NORTH DAKOTA NO. 11

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

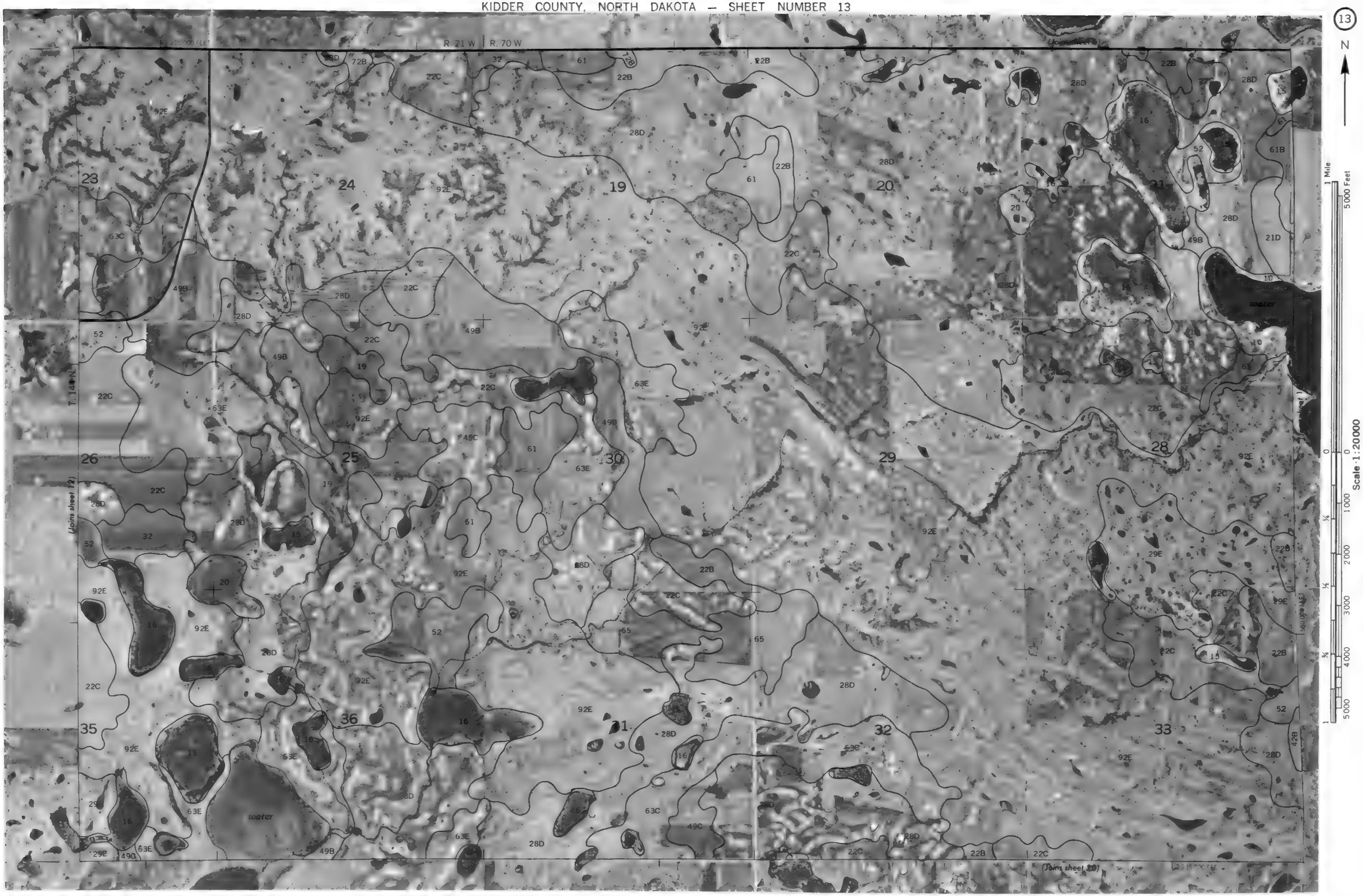


(12)



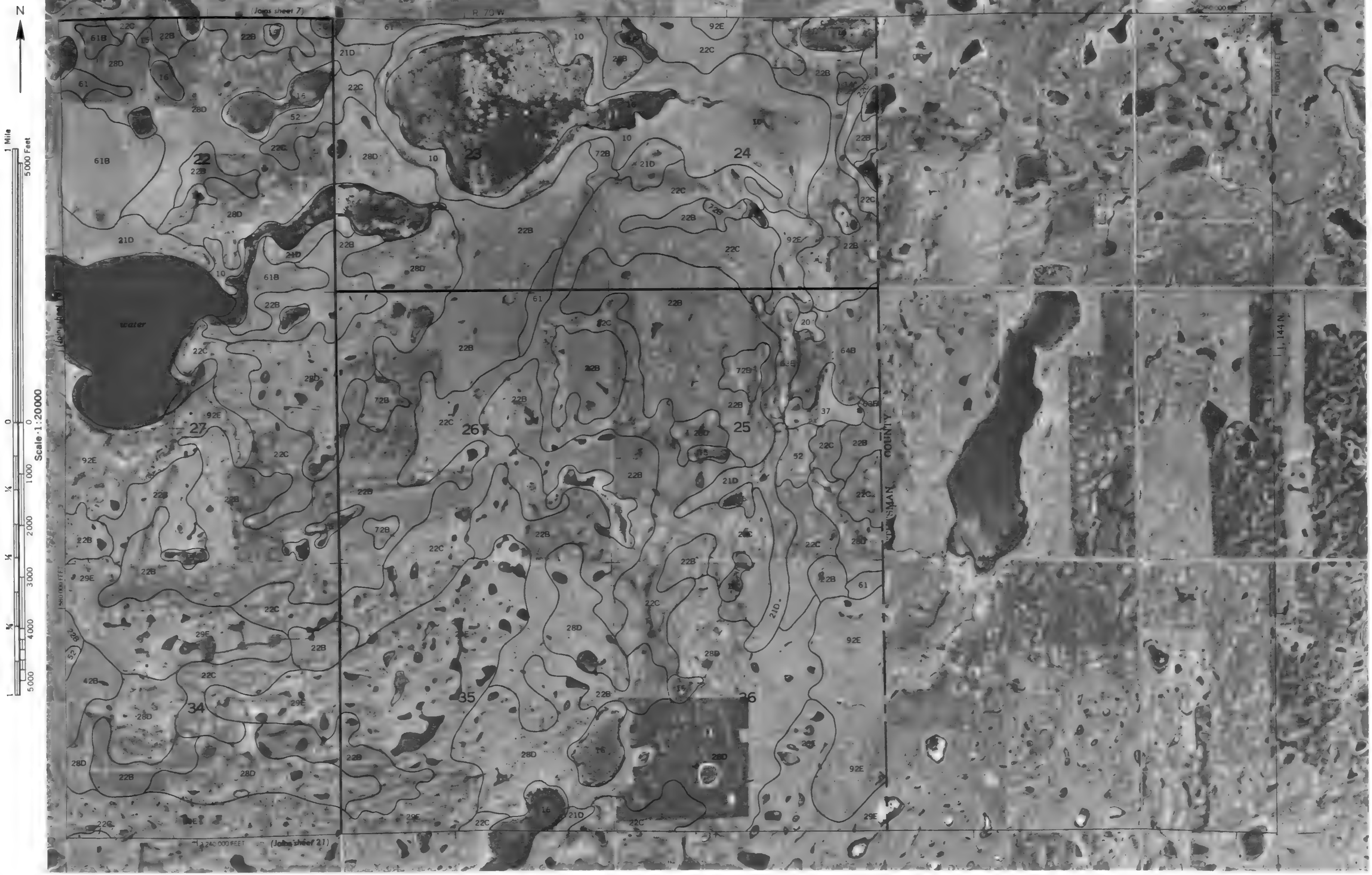
KIDDER COUNTY, NORTH DAKOTA NO. 12

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



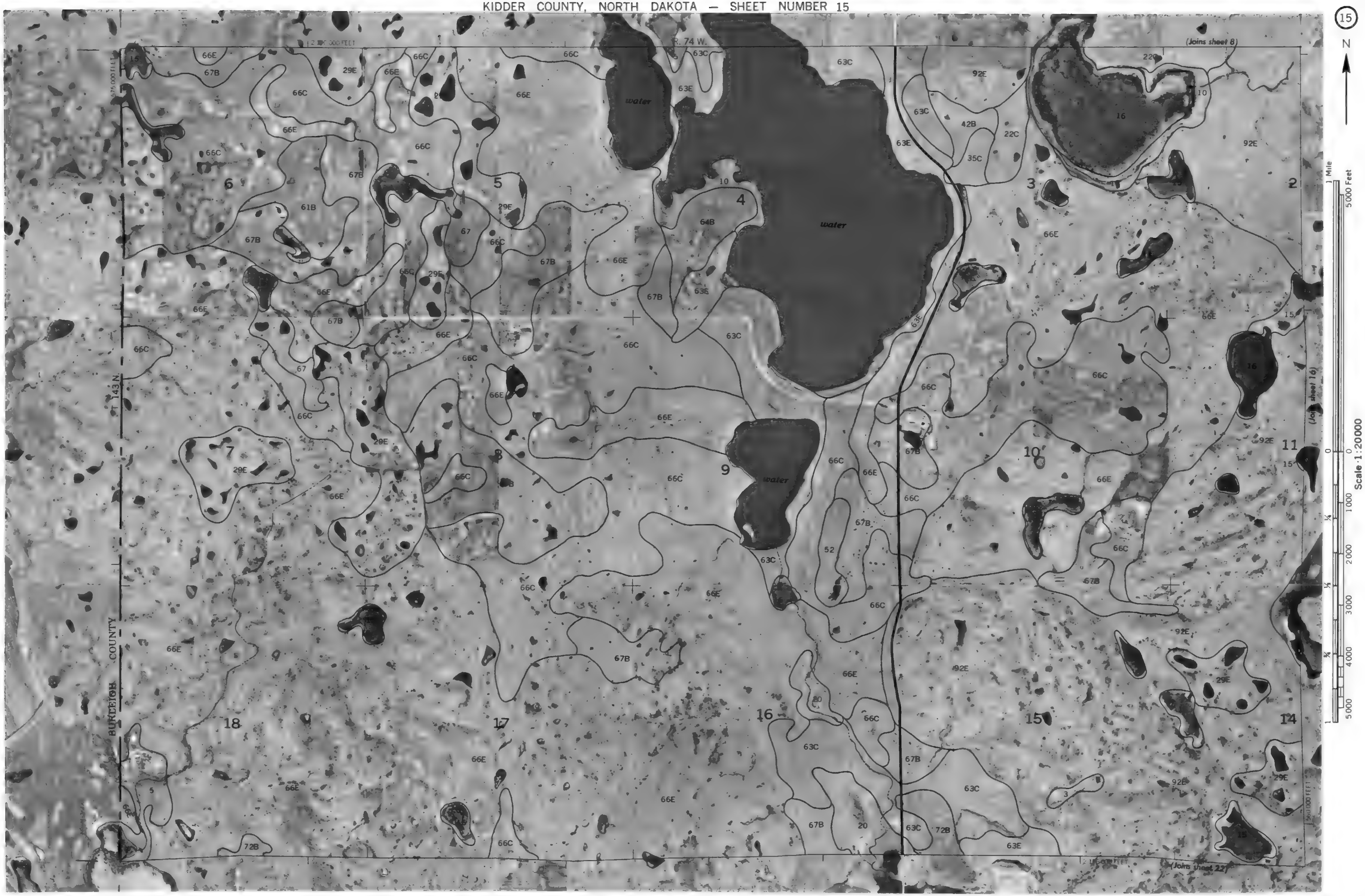
KIDDER COUNTY, NORTH DAKOTA NO. 13

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



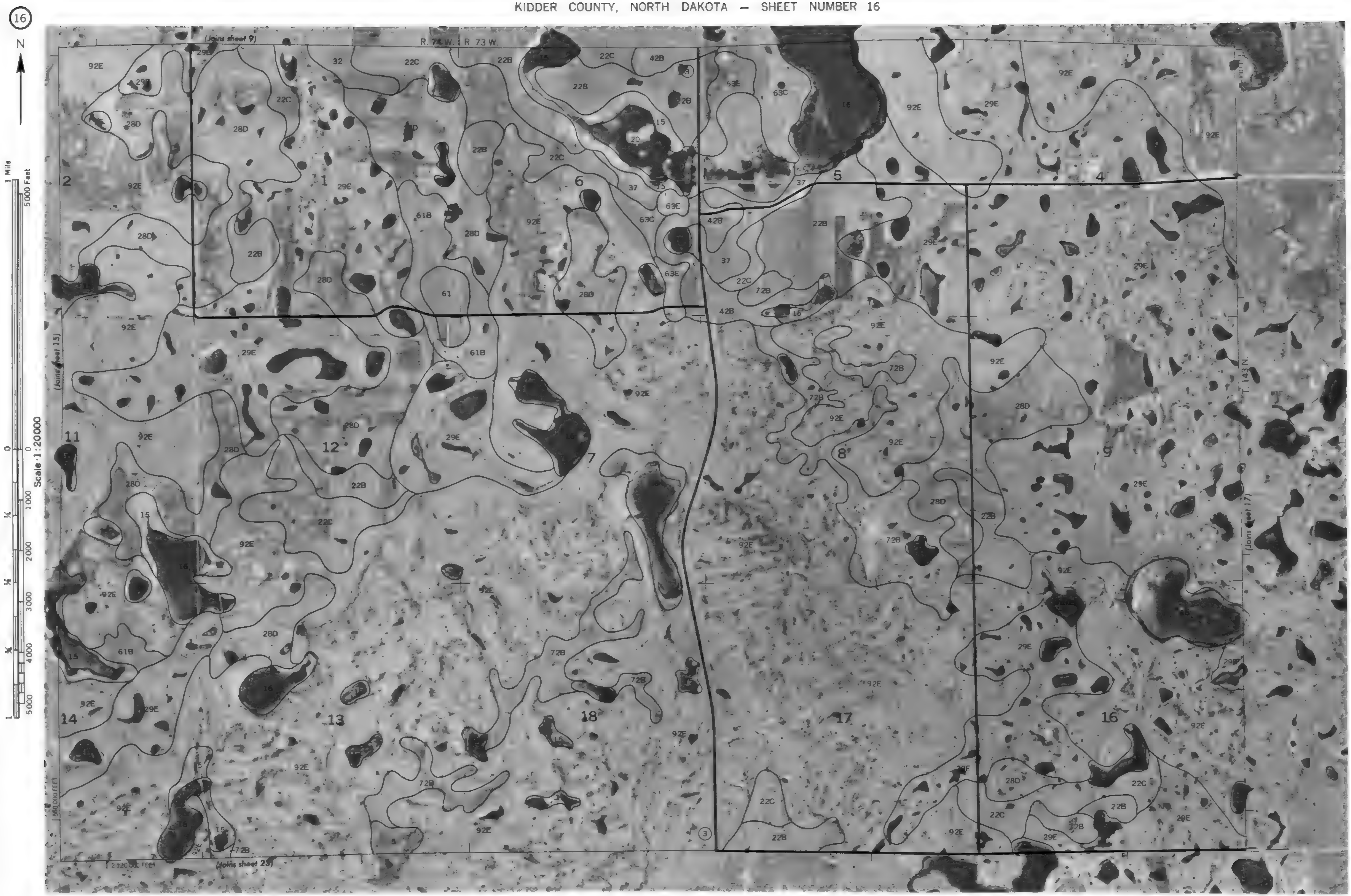
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

KIDDER COUNTY, NORTH DAKOTA NO. 14



KIDDER COUNTY, NORTH DAKOTA NO. 15

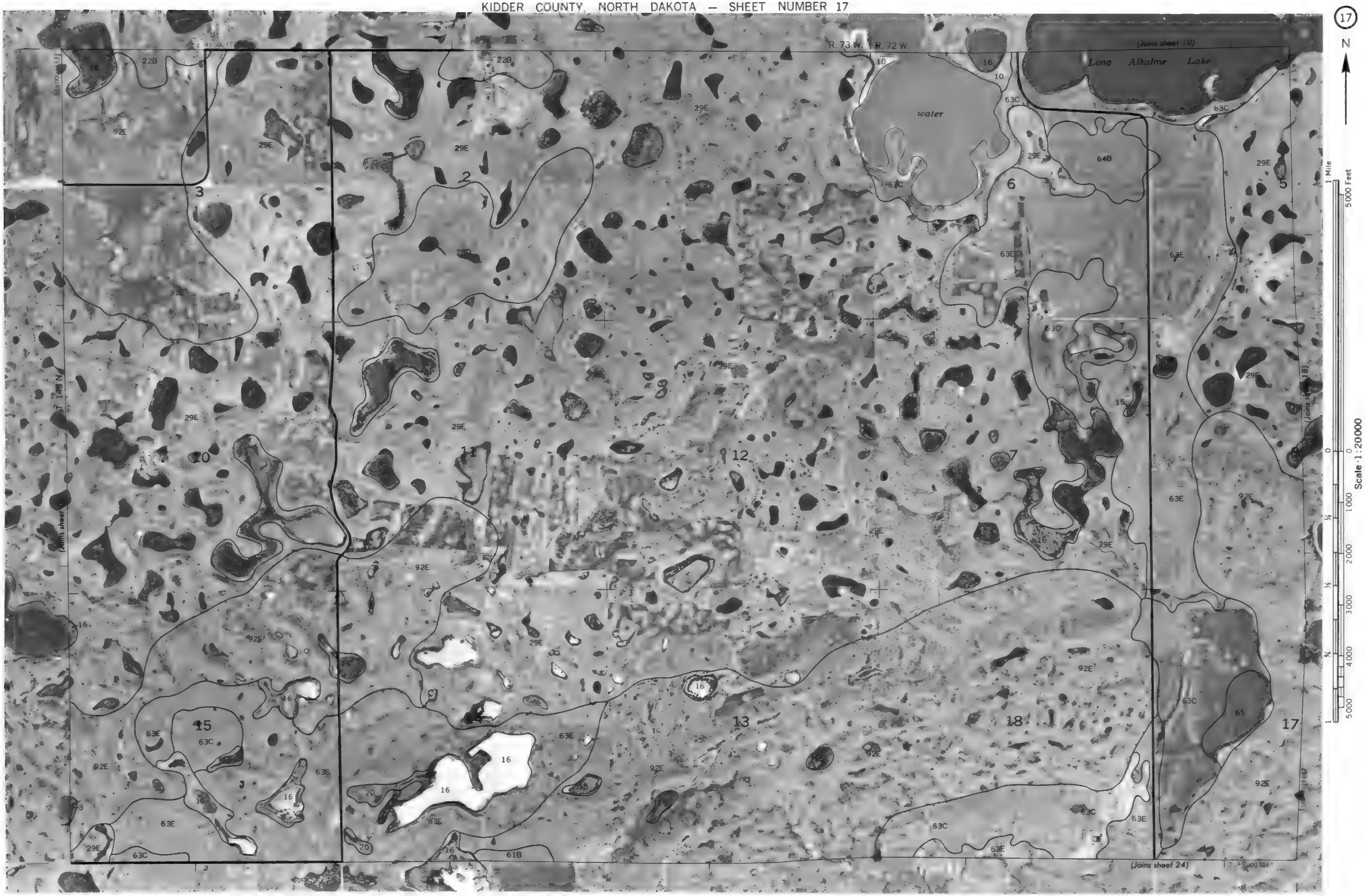
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Servi[redacted] cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned

KIDDER COUNTY, NORTH DAKOTA NO. 16

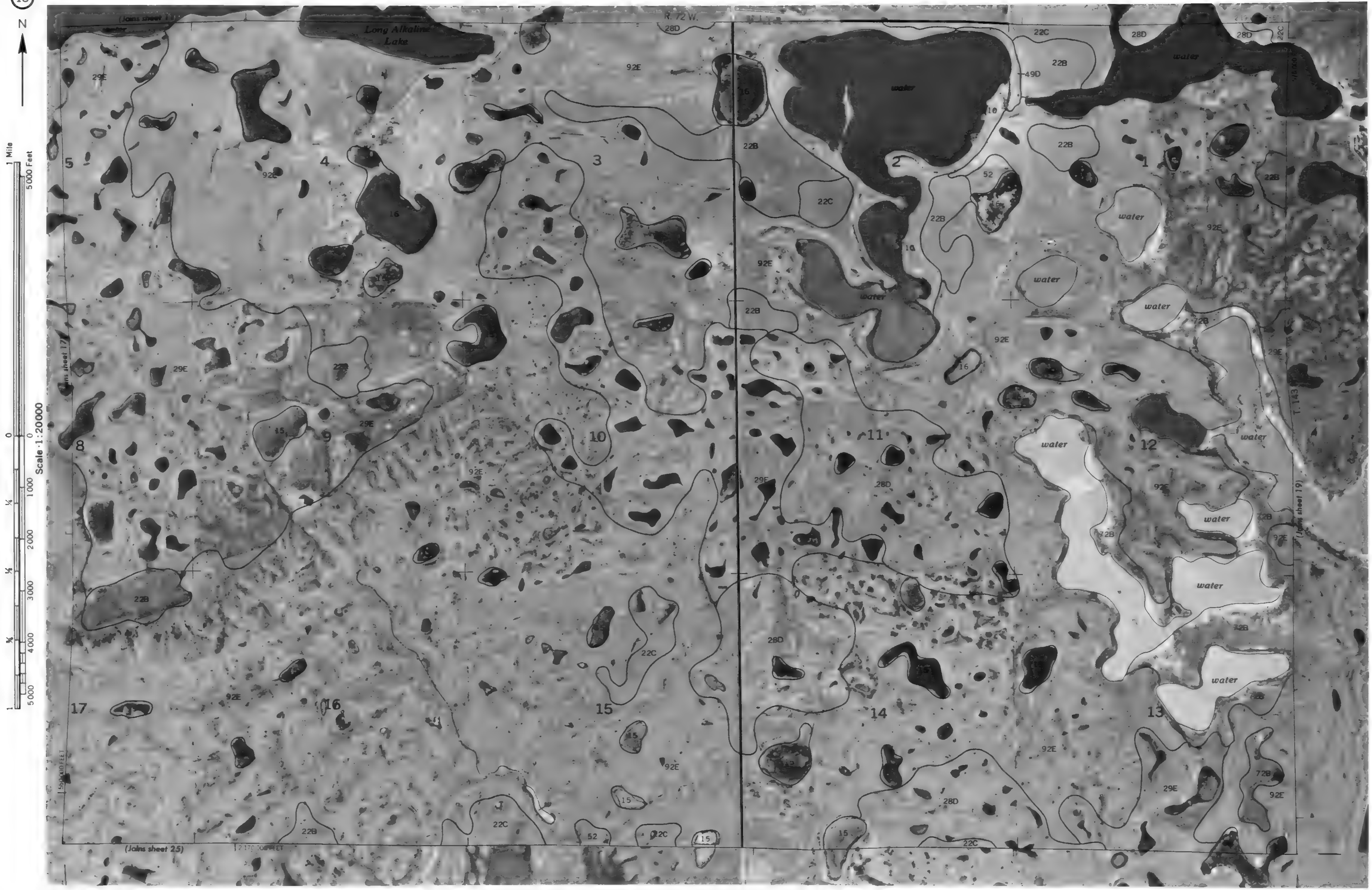
KIDDER COUNTY, NORTH DAKOTA — SHEET NUMBER 17



KIDDER COUNTY, NORTH DAKOTA NO. 17

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

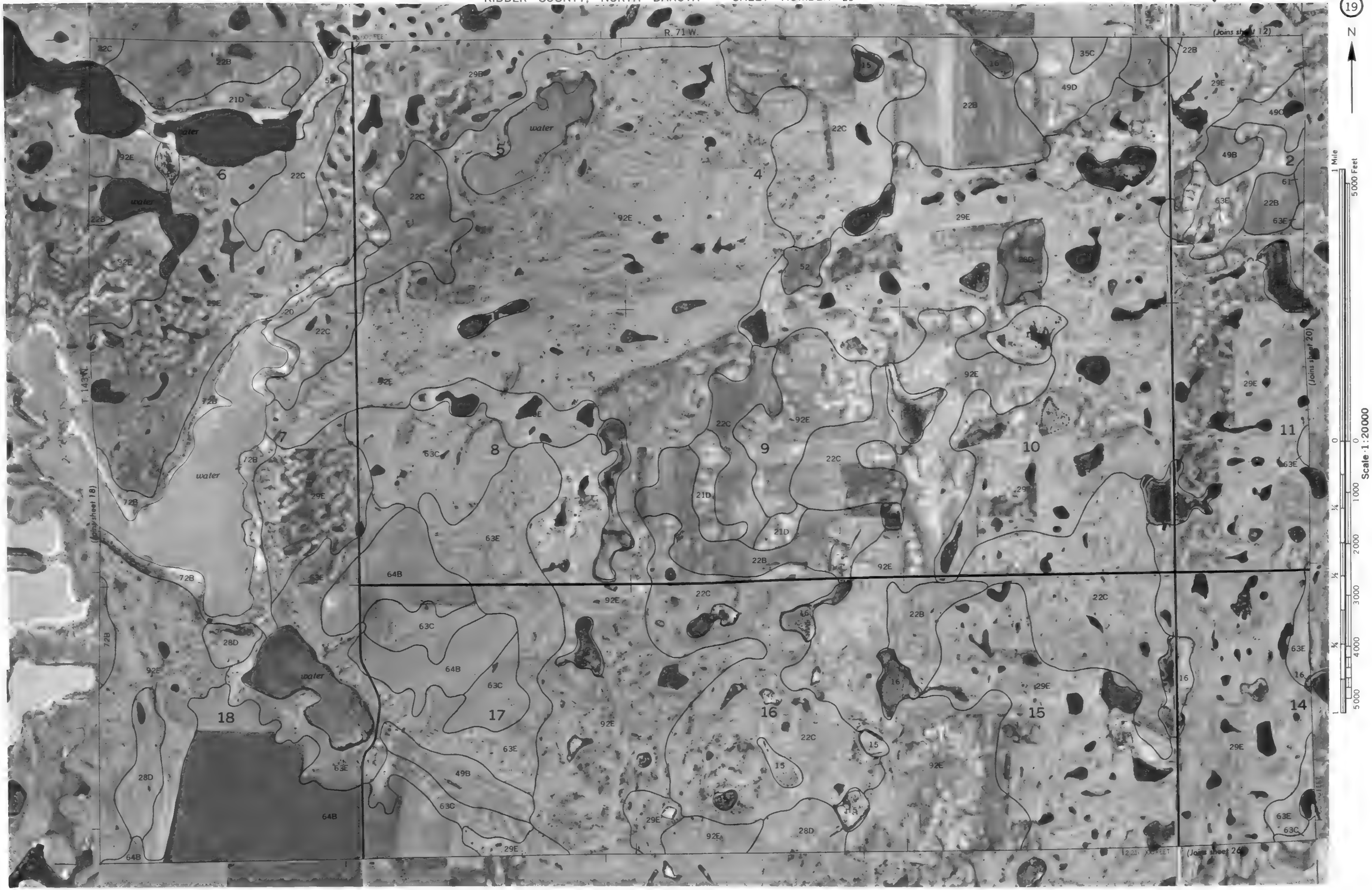
KIDDER COUNTY, NORTH DAKOTA — SHEET NUMBER 18



KIDDER COUNTY, NORTH DAKOTA NO. 18

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned

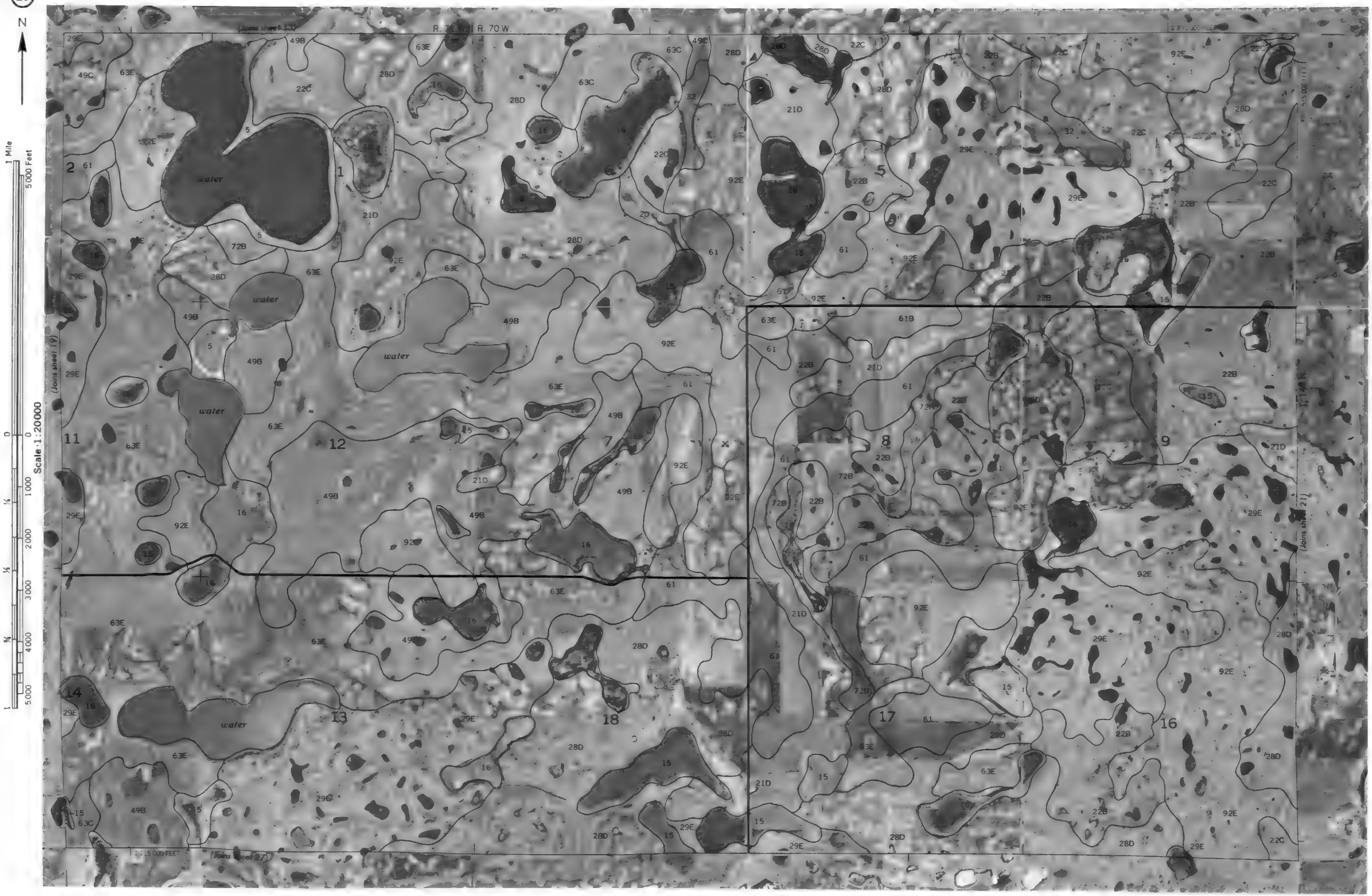
KIDDER COUNTY, NORTH DAKOTA — SHEET NUMBER 19



KIDDER COUNTY, NORTH DAKOTA NO. 19

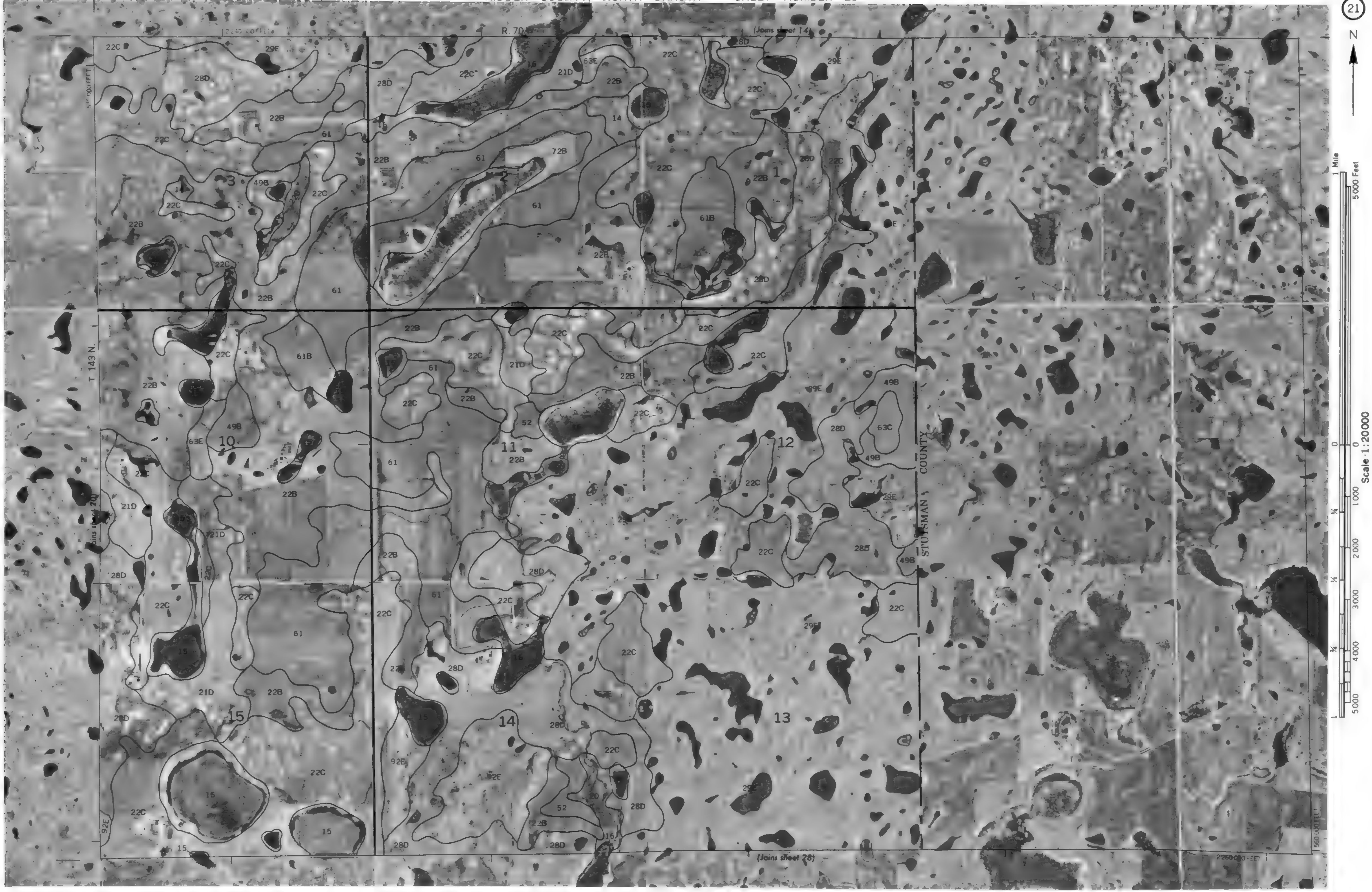
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned

KIDDER COUNTY, NORTH DAKOTA — SHEET NUMBER 20



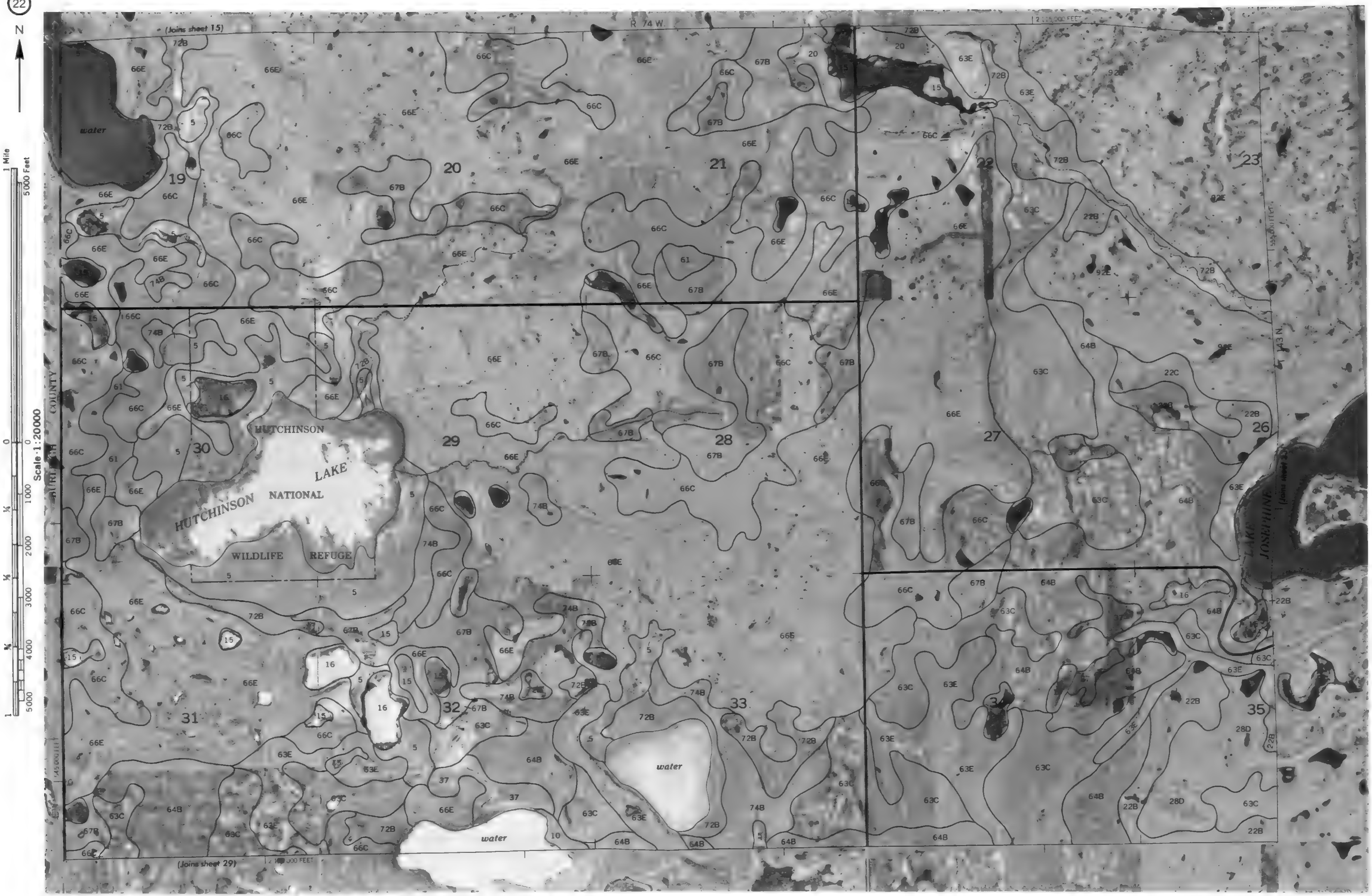
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

KIDDER COUNTY, NORTH DAKOTA NO. 20



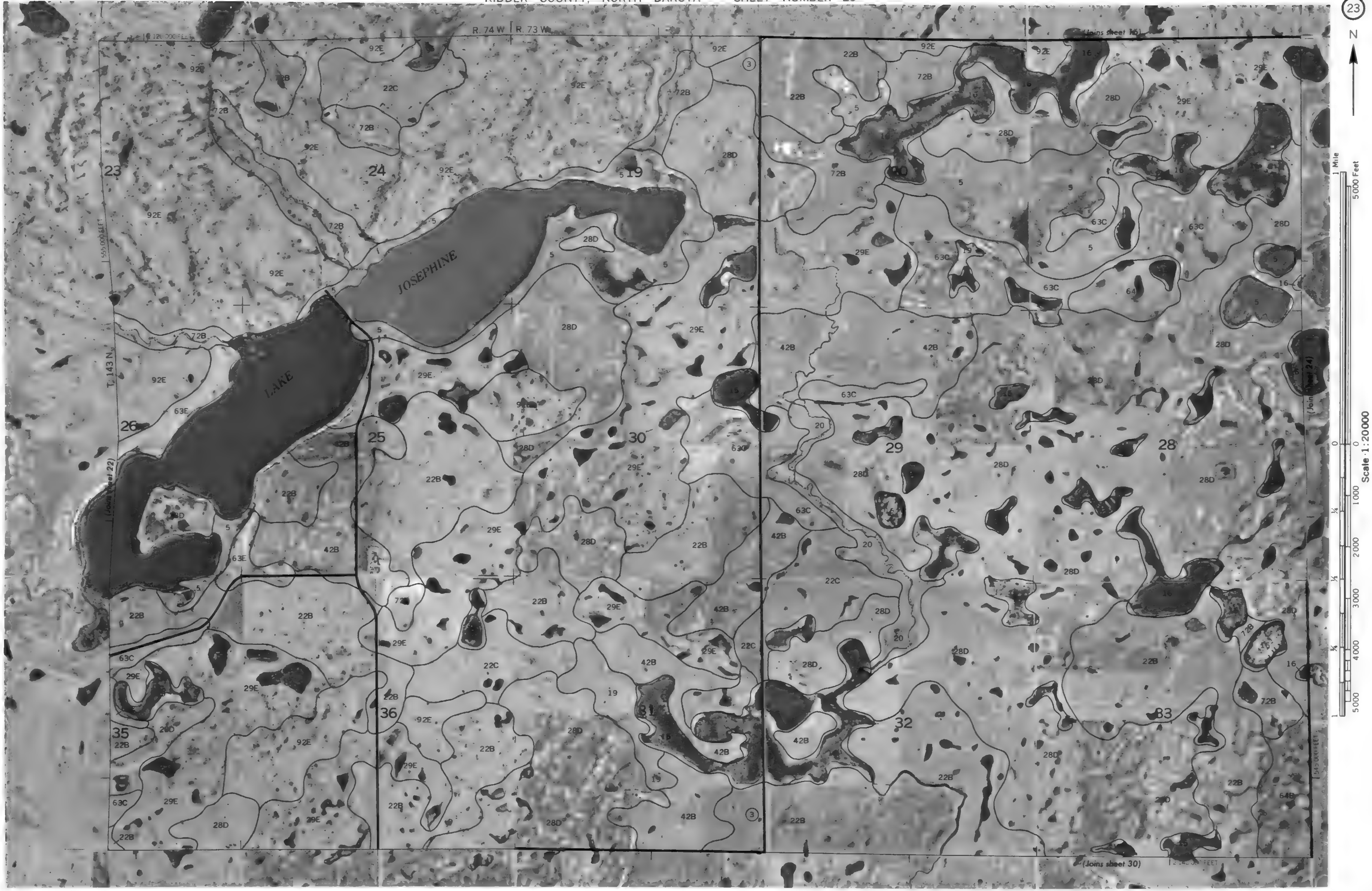
KIDDER COUNTY, NORTH DAKOTA NO. 21

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



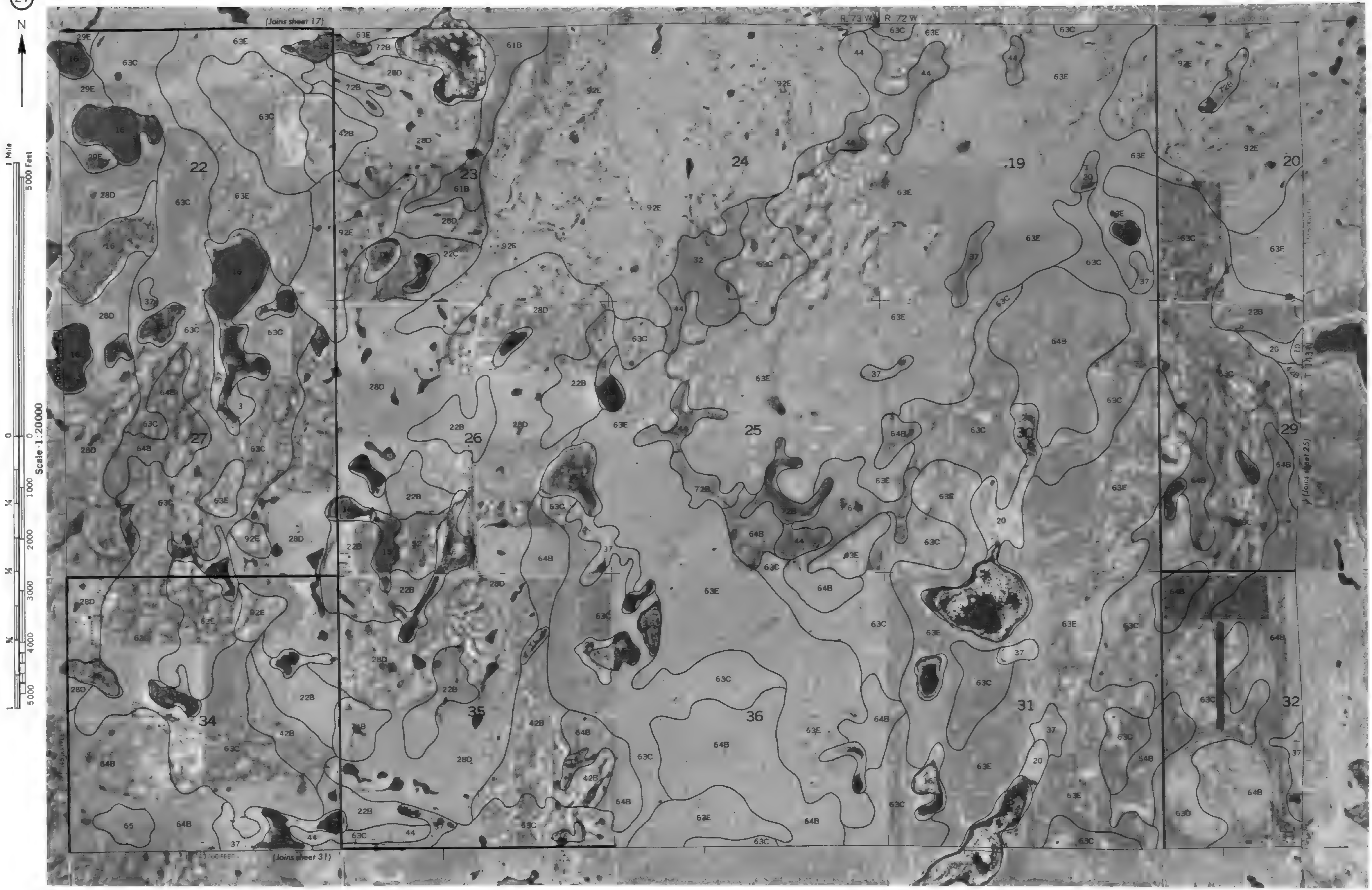
KIDDER COUNTY, NORTH DAKOTA NO. 22

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



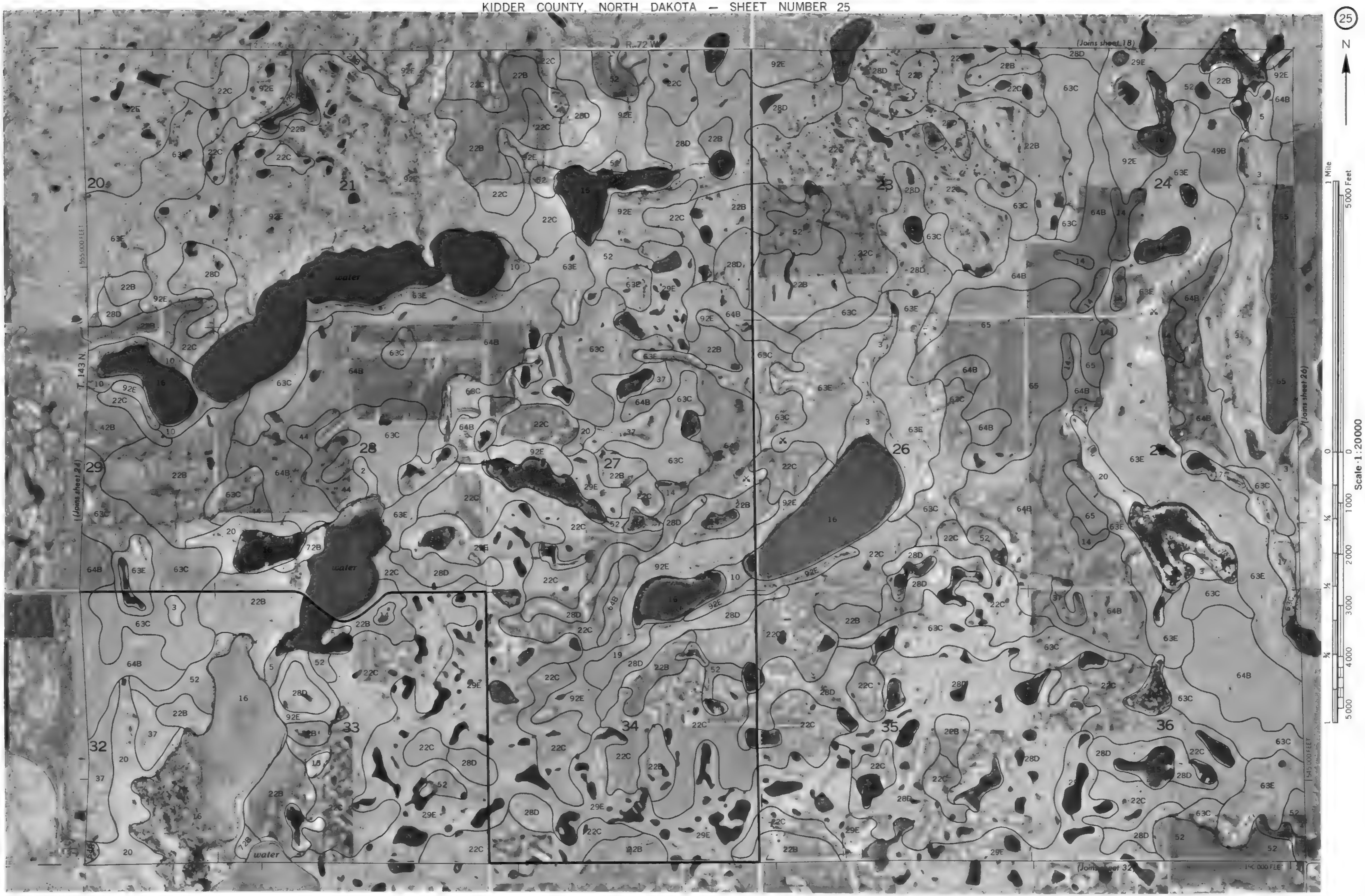
KIDDER COUNTY, NORTH DAKOTA NO. 23

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



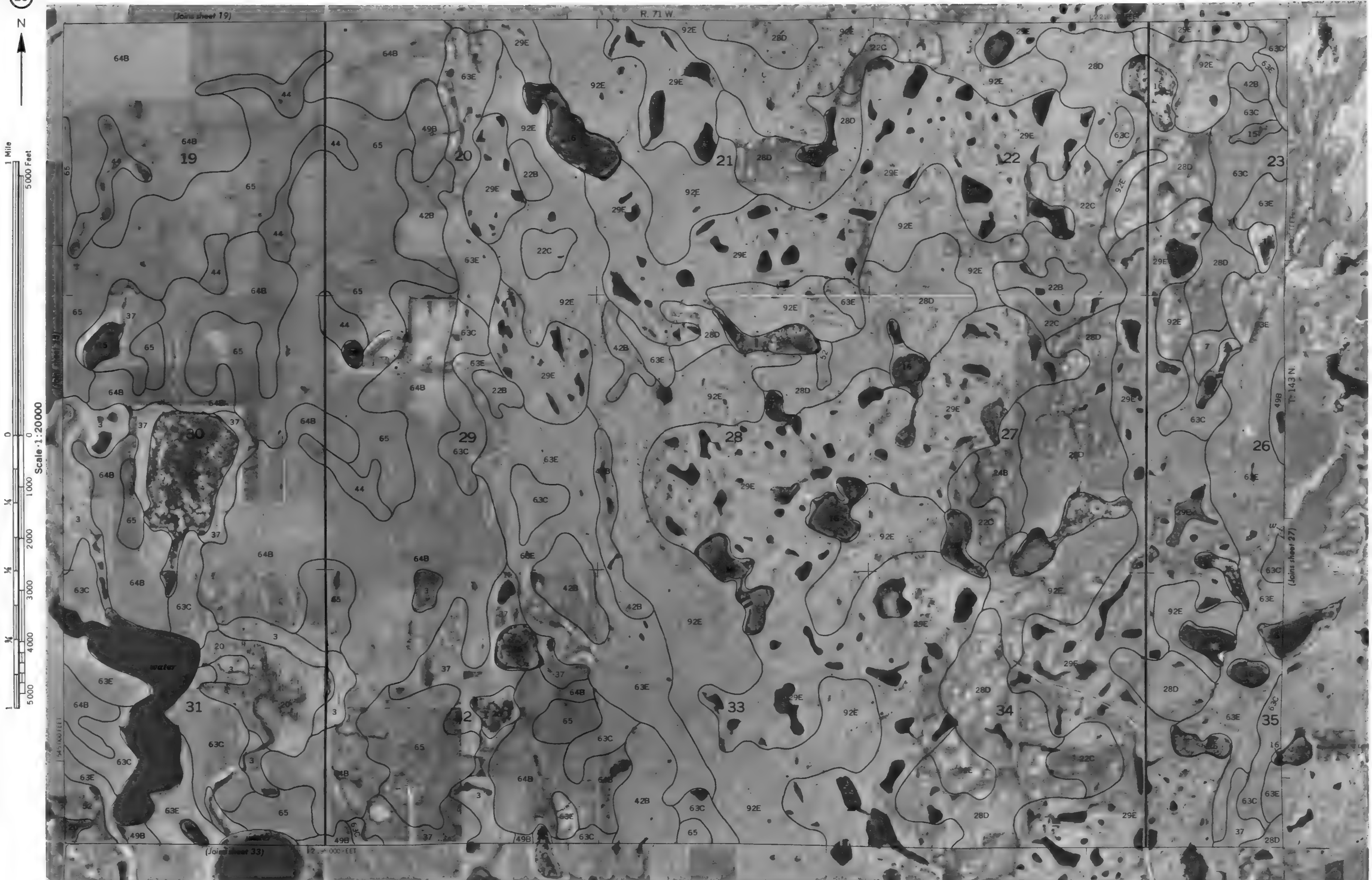
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

KIDDER COUNTY, NORTH DAKOTA NO. 24

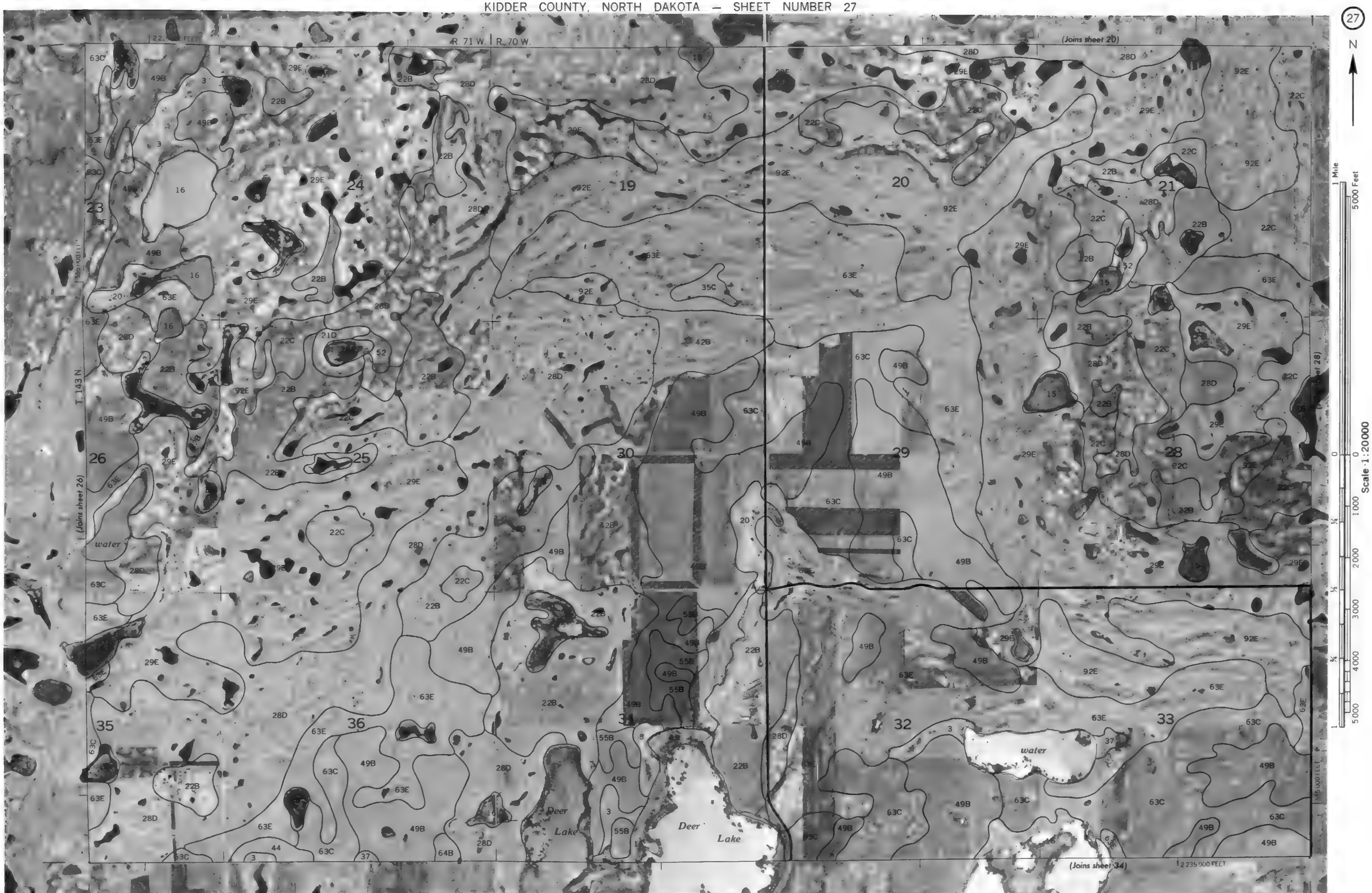


KIDDER COUNTY, NORTH DAKOTA NO. 25

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

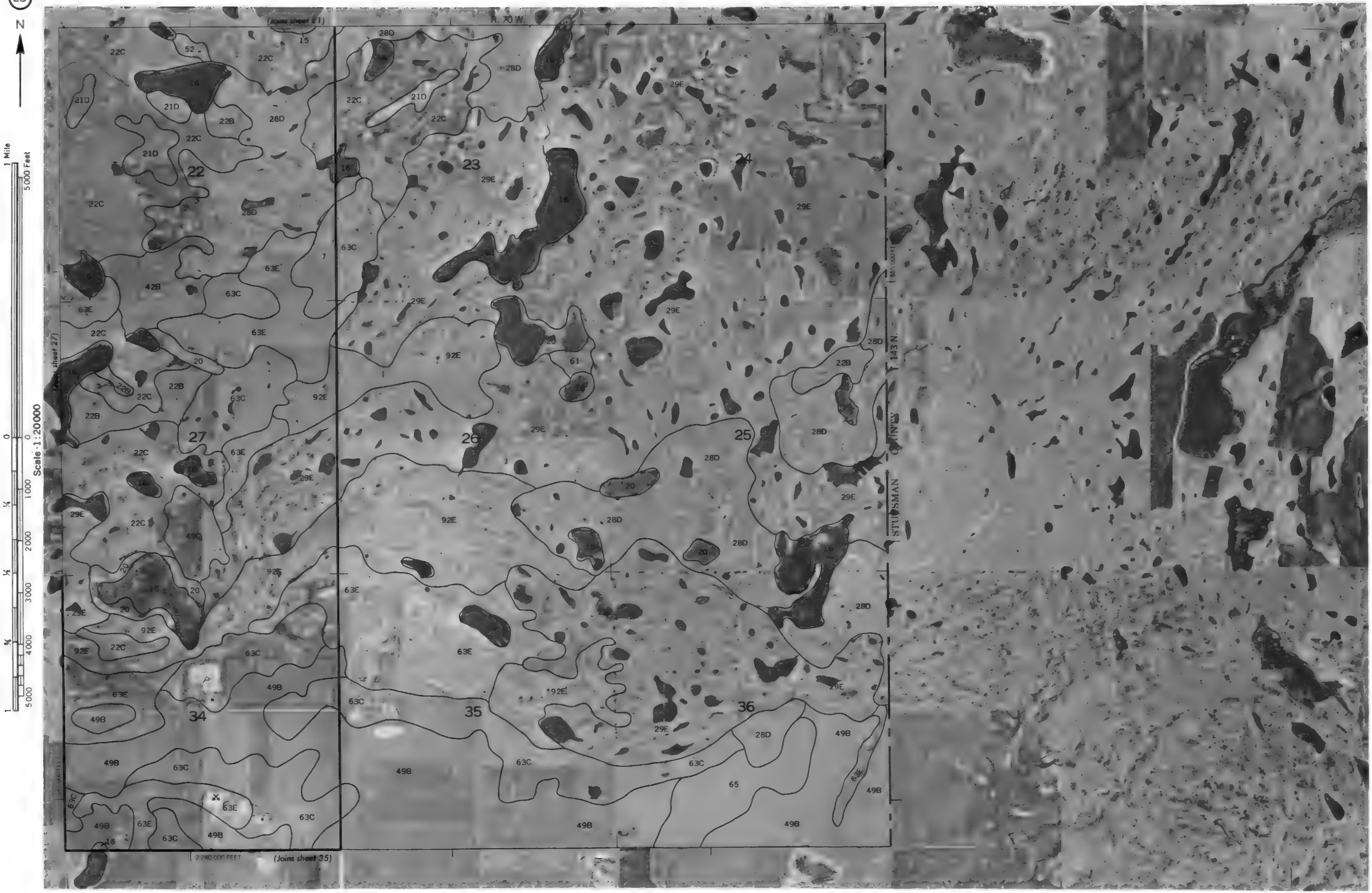


This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



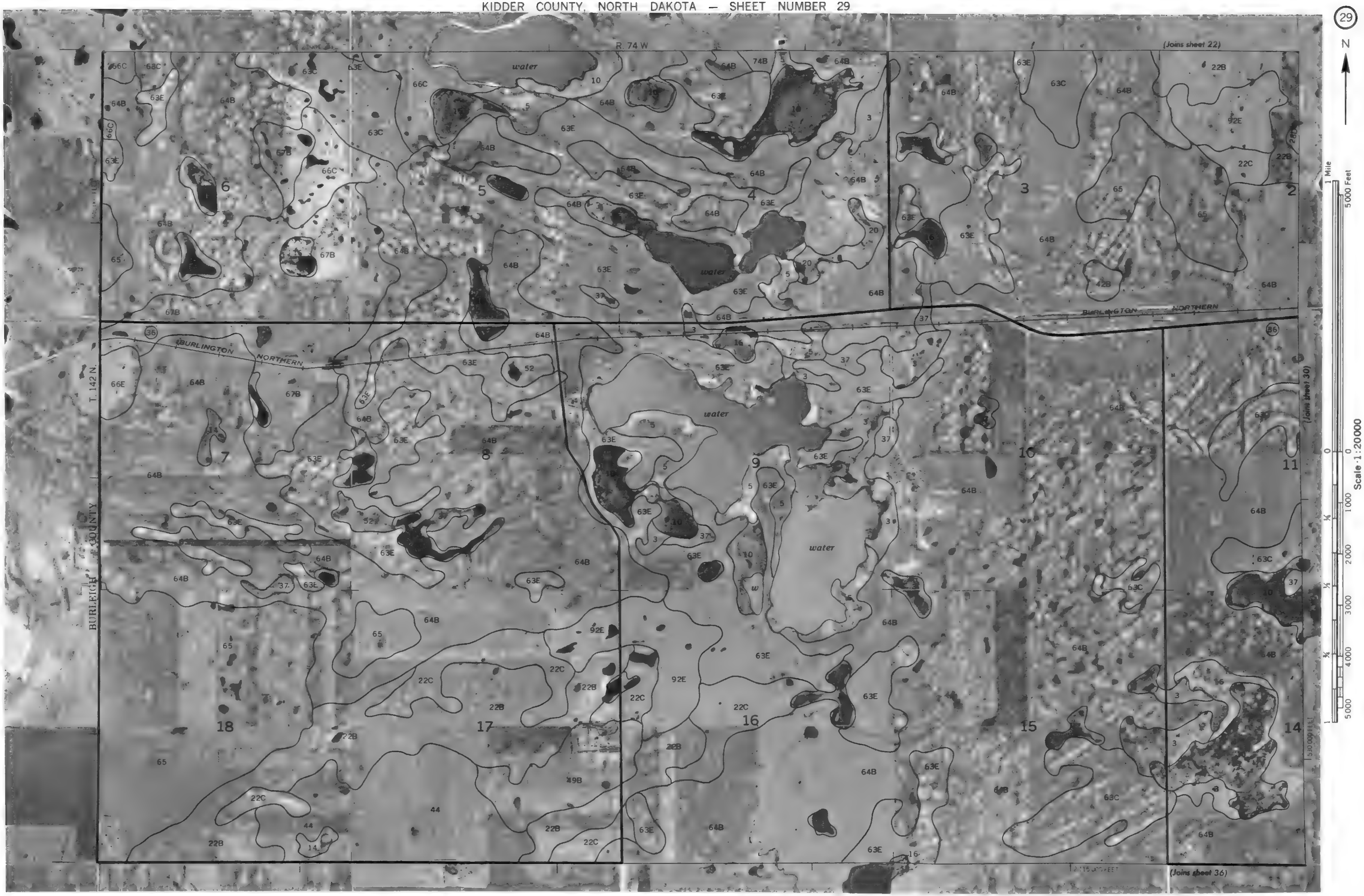
KIDDER COUNTY, NORTH DAKOTA NO. 27

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



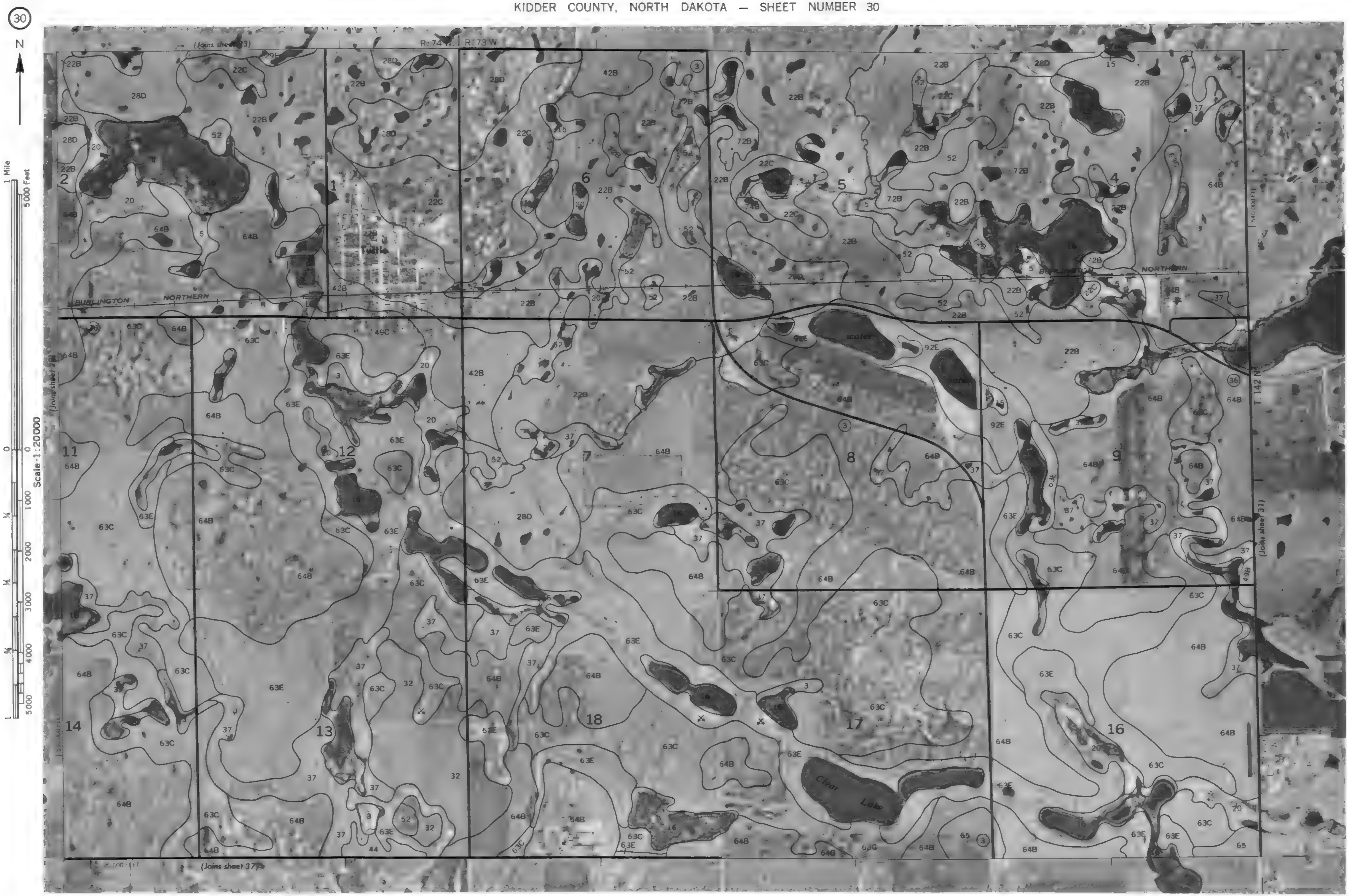
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

KIDDER COUNTY, NORTH DAKOTA NO. 28



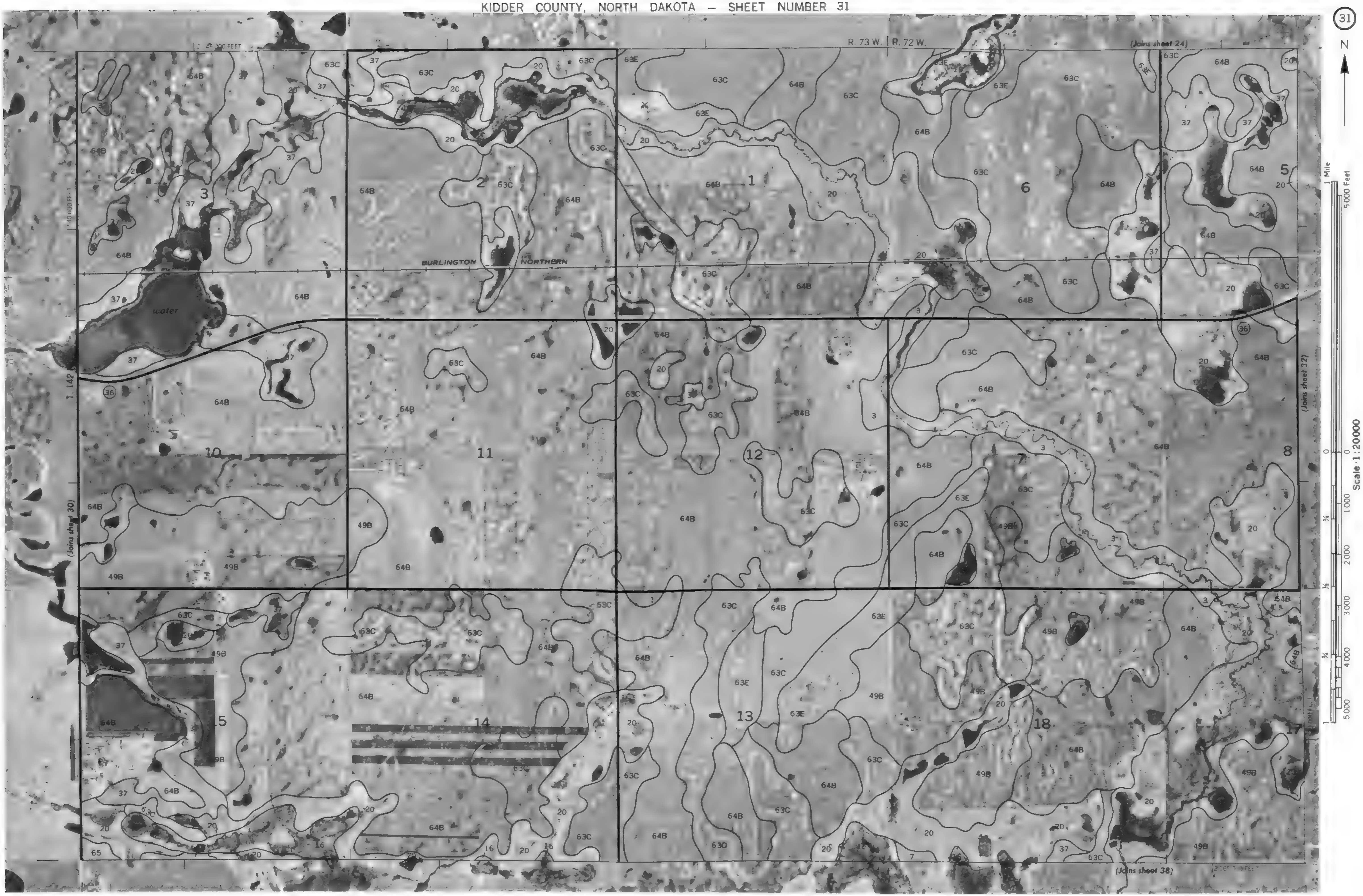
KIDDER COUNTY, NORTH DAKOTA NO. 29

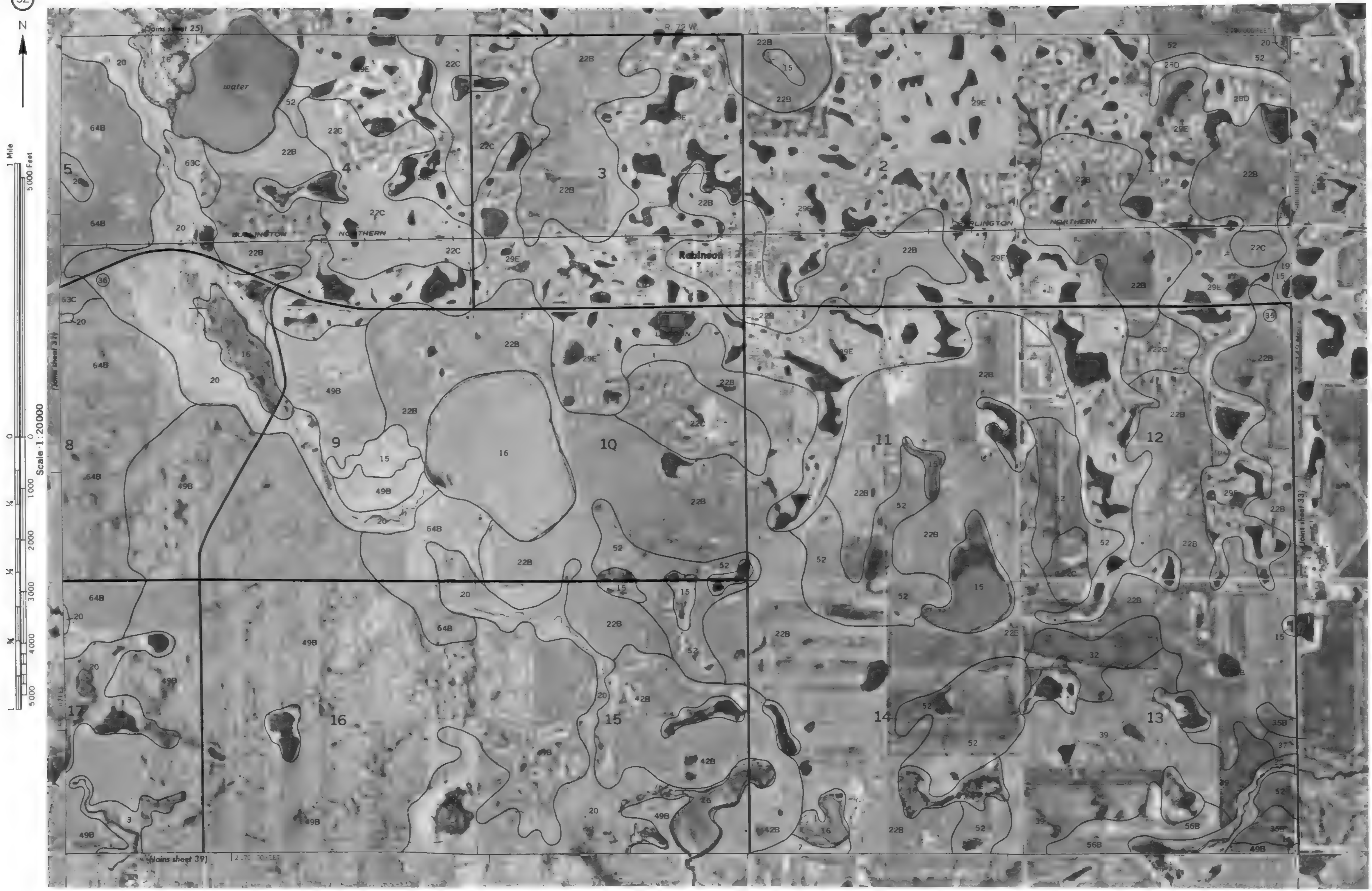
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



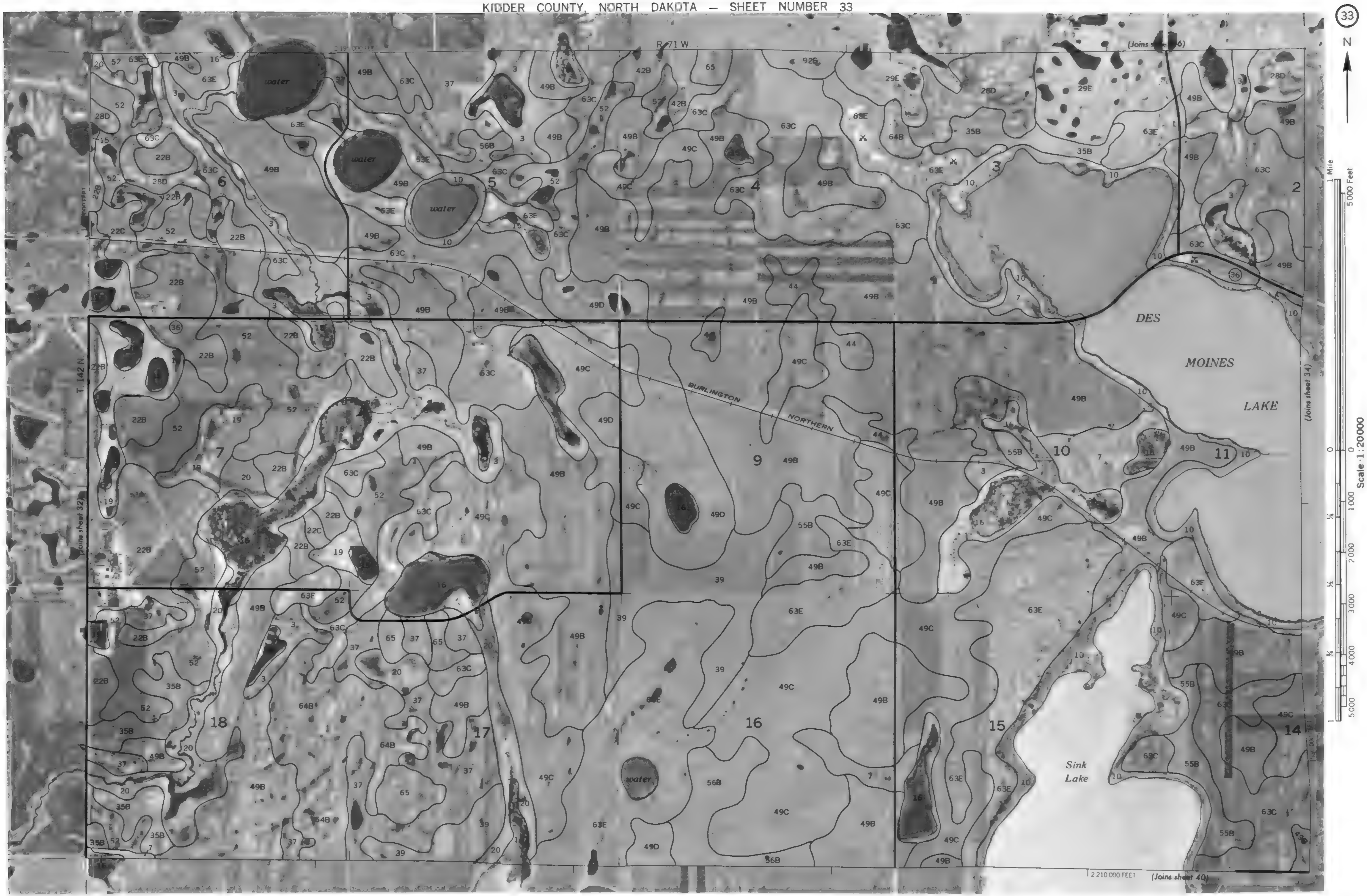
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

KIDDER COUNTY, NORTH DAKOTA NO. 30


R. 73 W. | R. 72 W.
(Joins sheet 24)
(Joins sheet 30)
(Joins sheet 32)
(Joins sheet 38)
T. 142
BURLINGTON NORTHERN
water
31
N
Scale 1:20000
1 Mile
5000 Feet

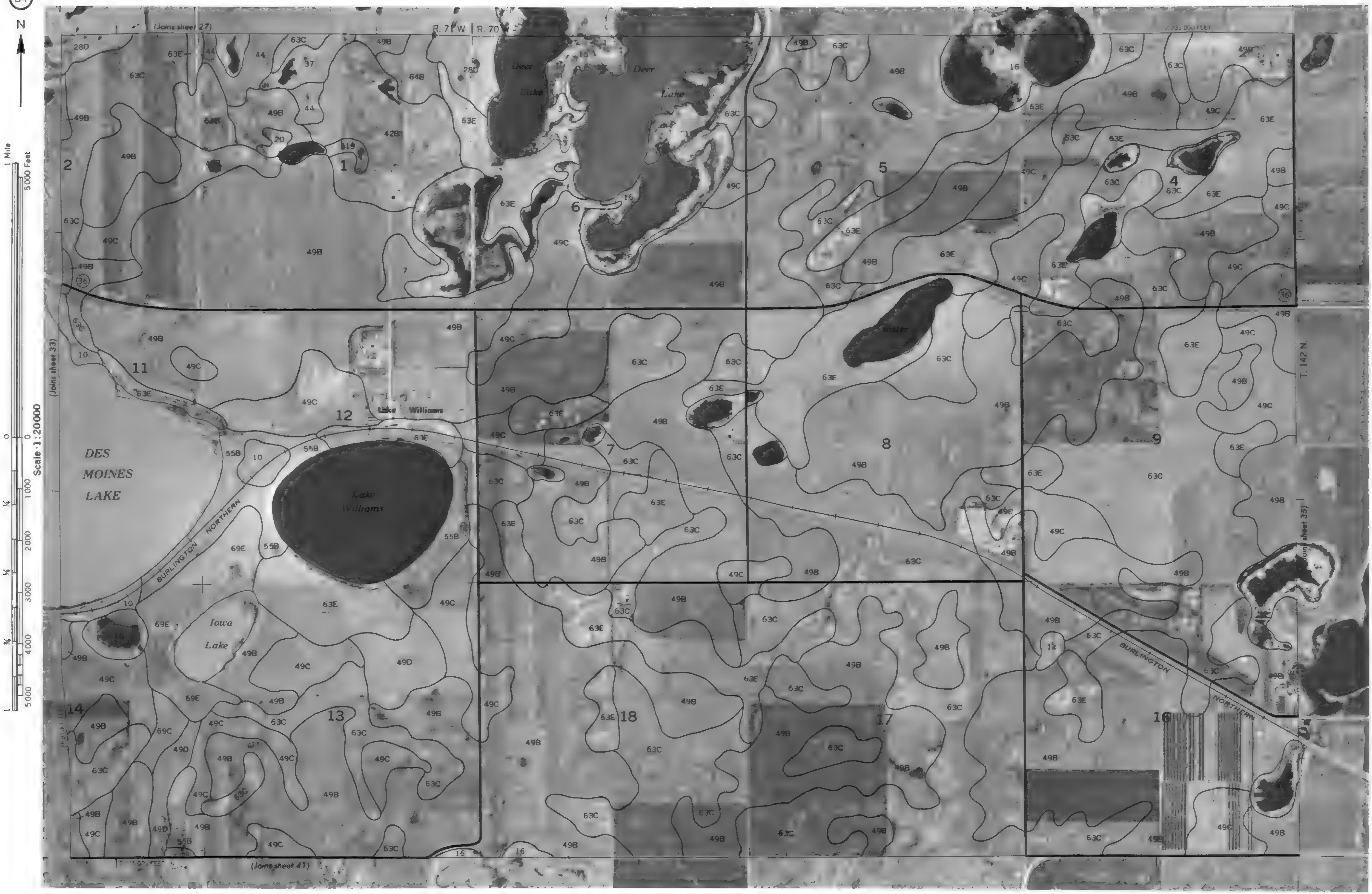


This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



KIDDER COUNTY, NORTH DAKOTA NO. 33

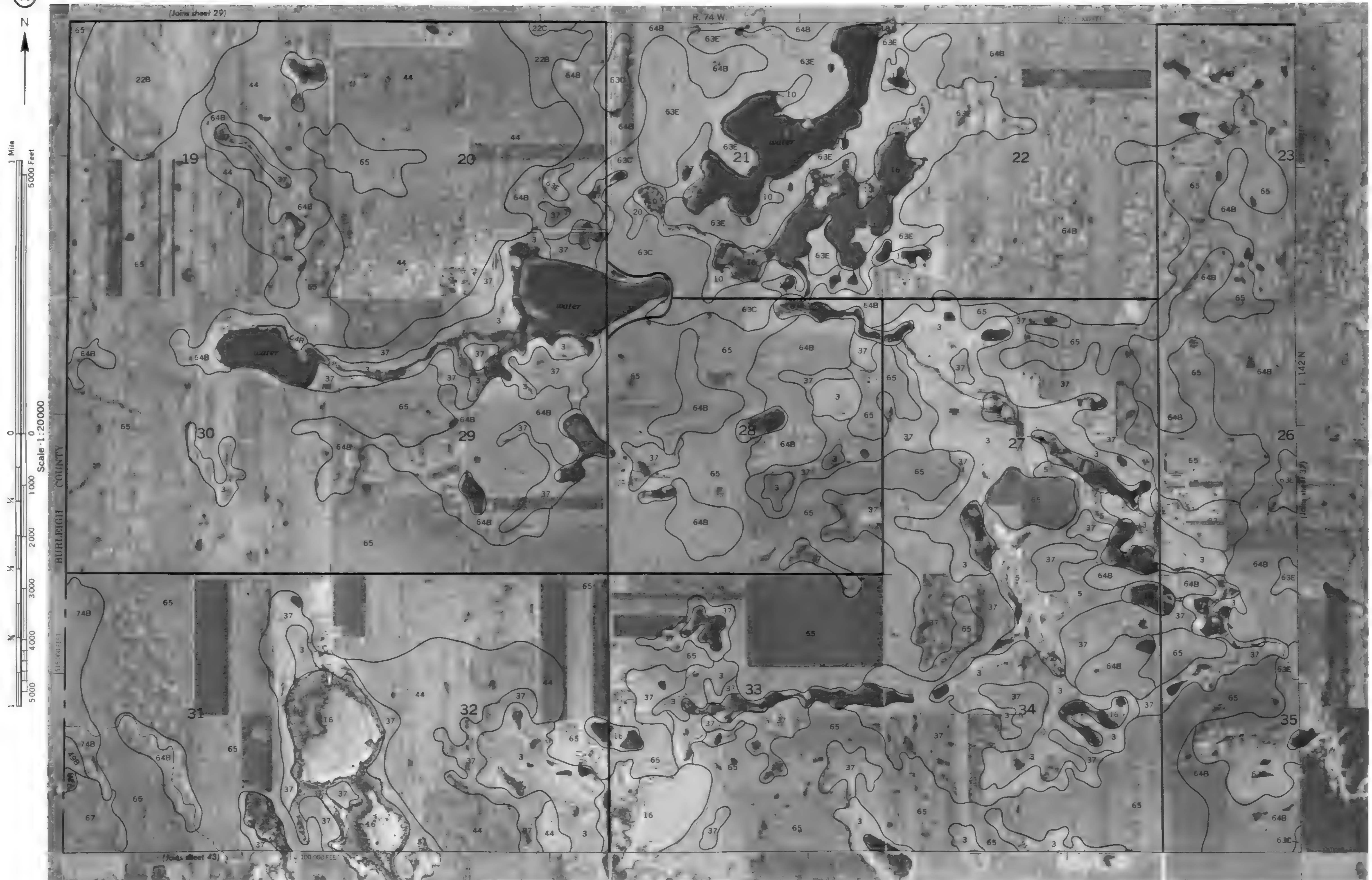
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

KIDDER COUNTY, NORTH DAKOTA NO. 35

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

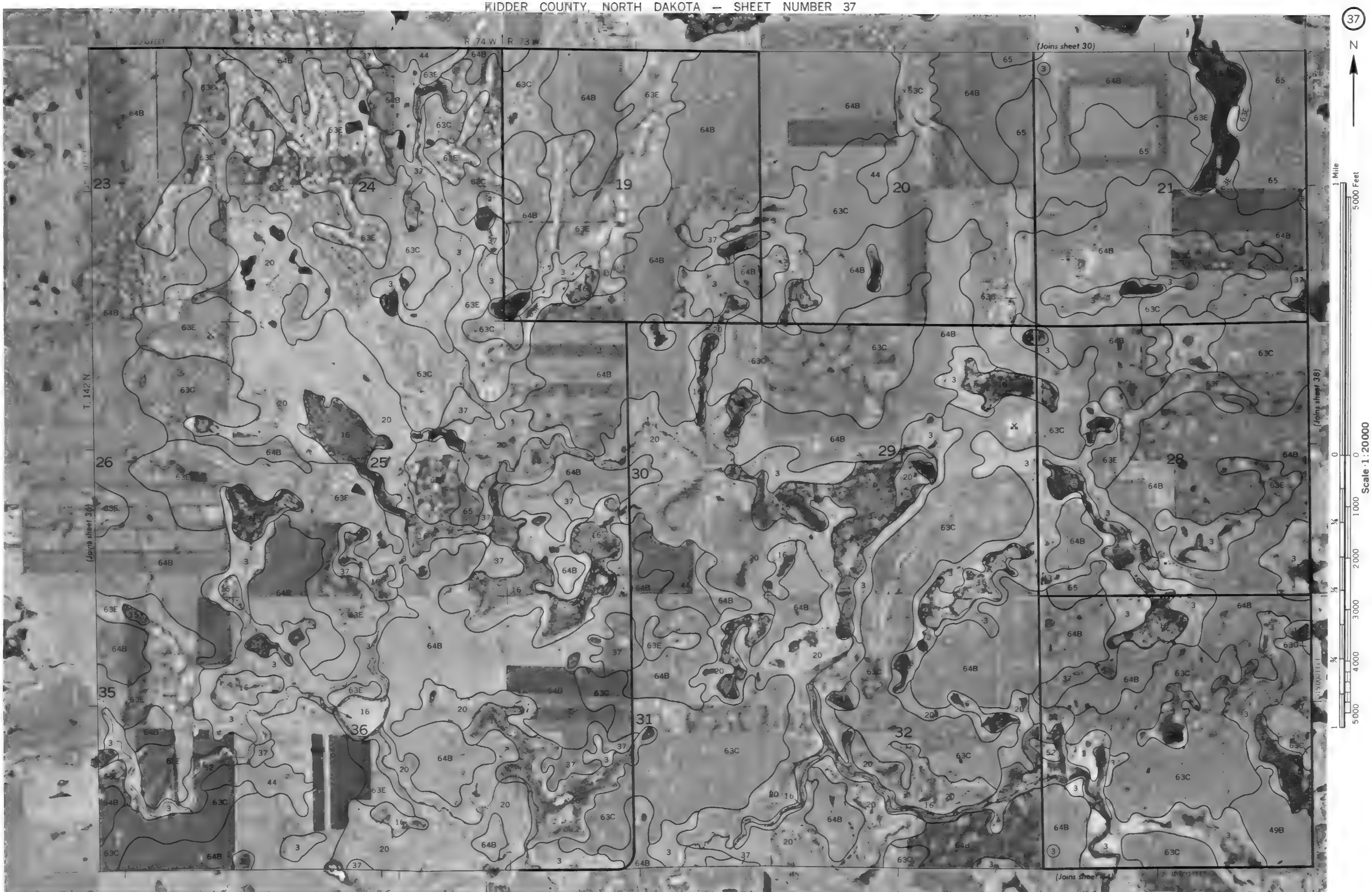


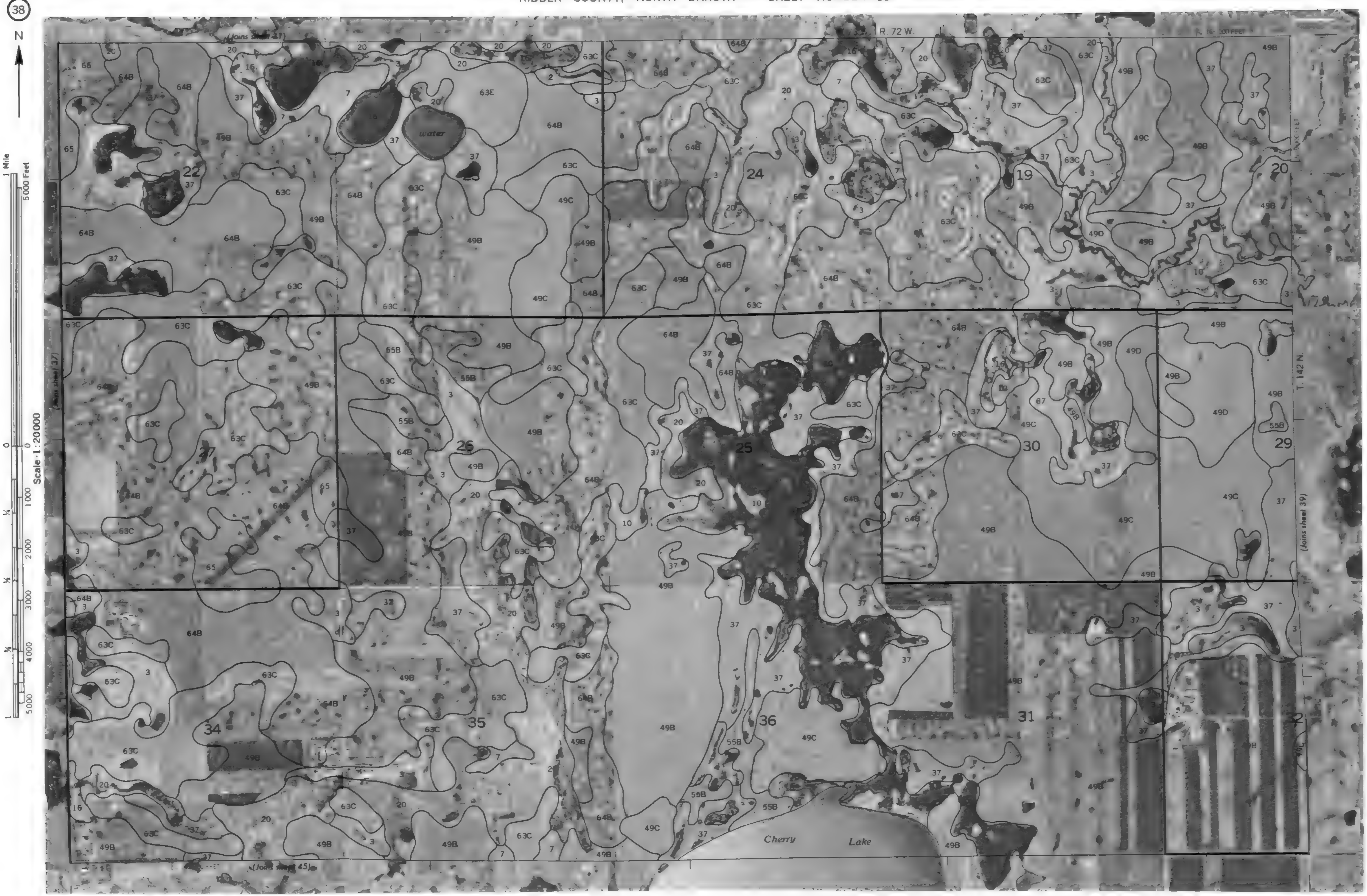
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

KIDDER COUNTY, NORTH DAKOTA NO. 36

KIDDER COUNTY, NORTH DAKOTA NO. 37

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



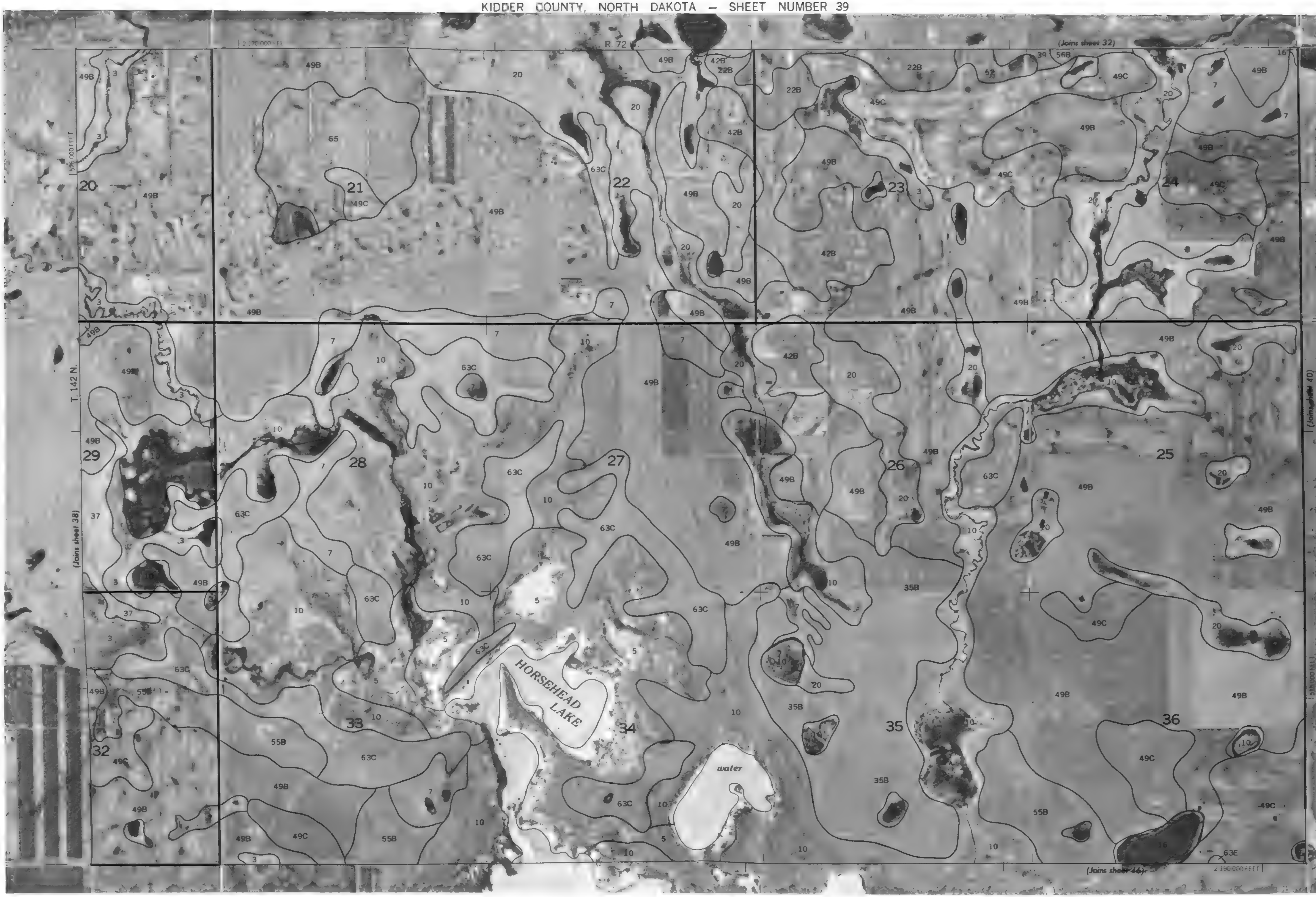


This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

KIDDER COUNTY, NORTH DAKOTA NO. 38

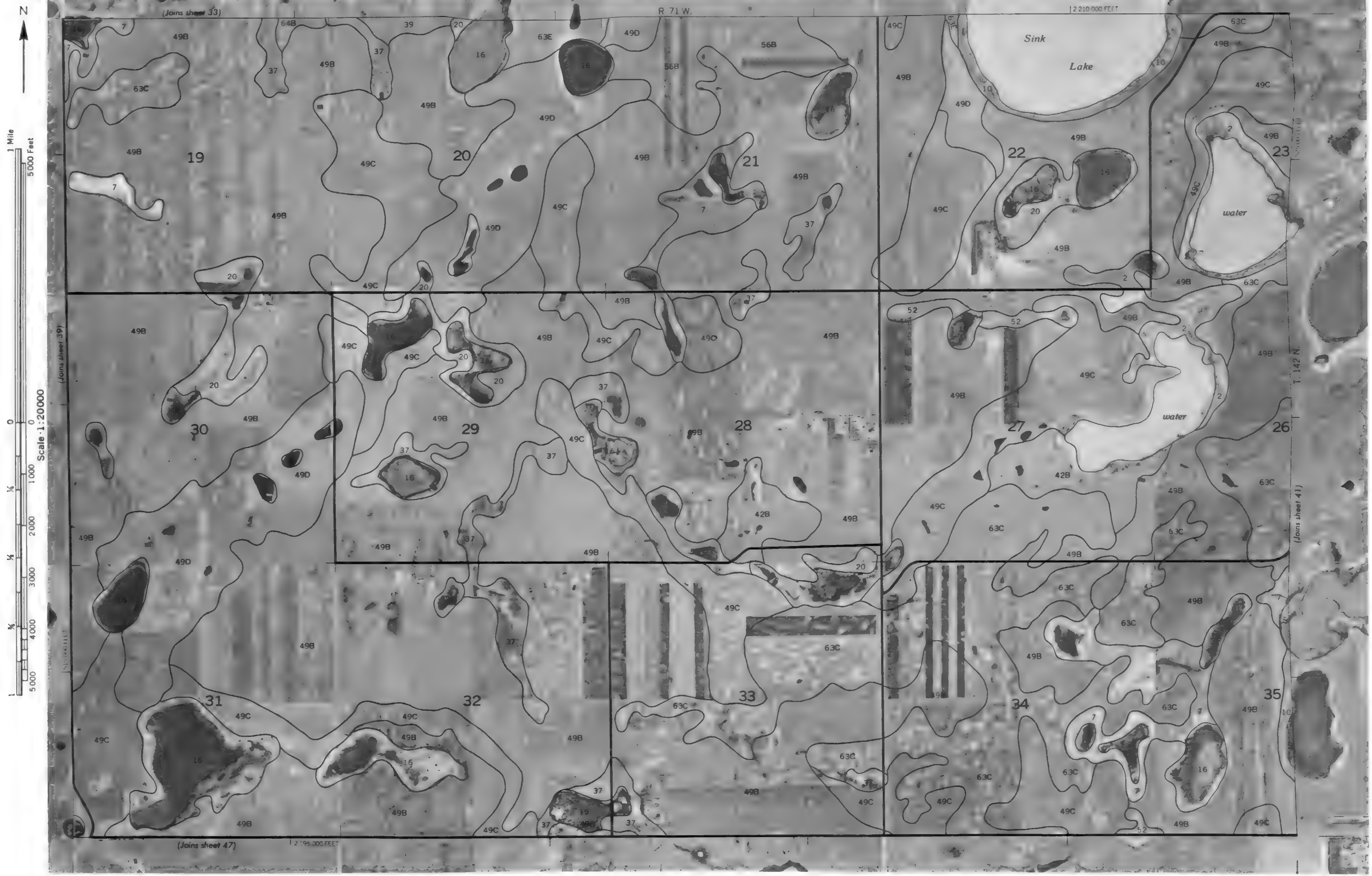
KIDDER COUNTY, NORTH DAKOTA NO. 39

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

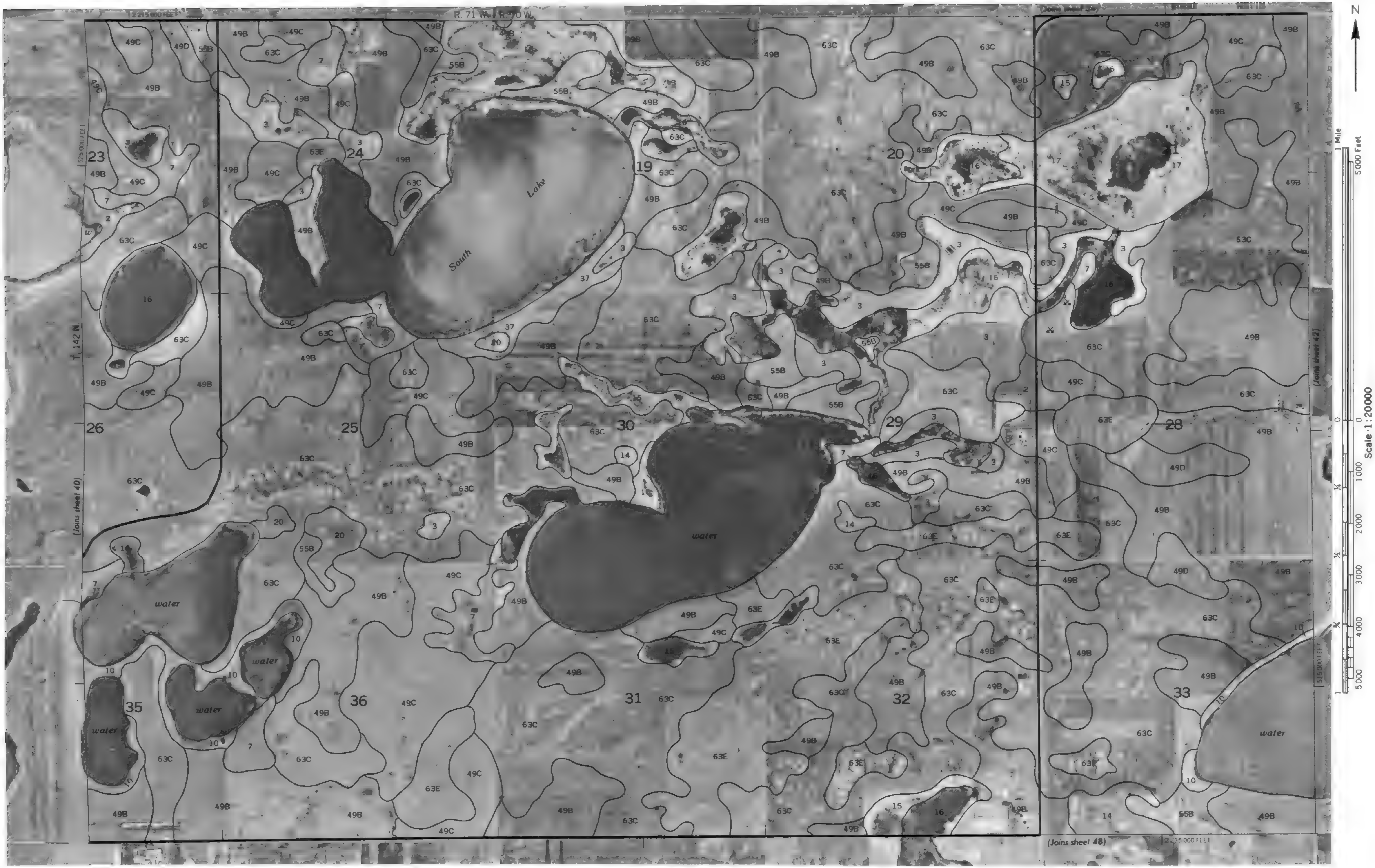


N

Scale 1:20000
1 Mile
5000 Feet
0
1000
2000
3000
4000
5000
¼
½
¾
1

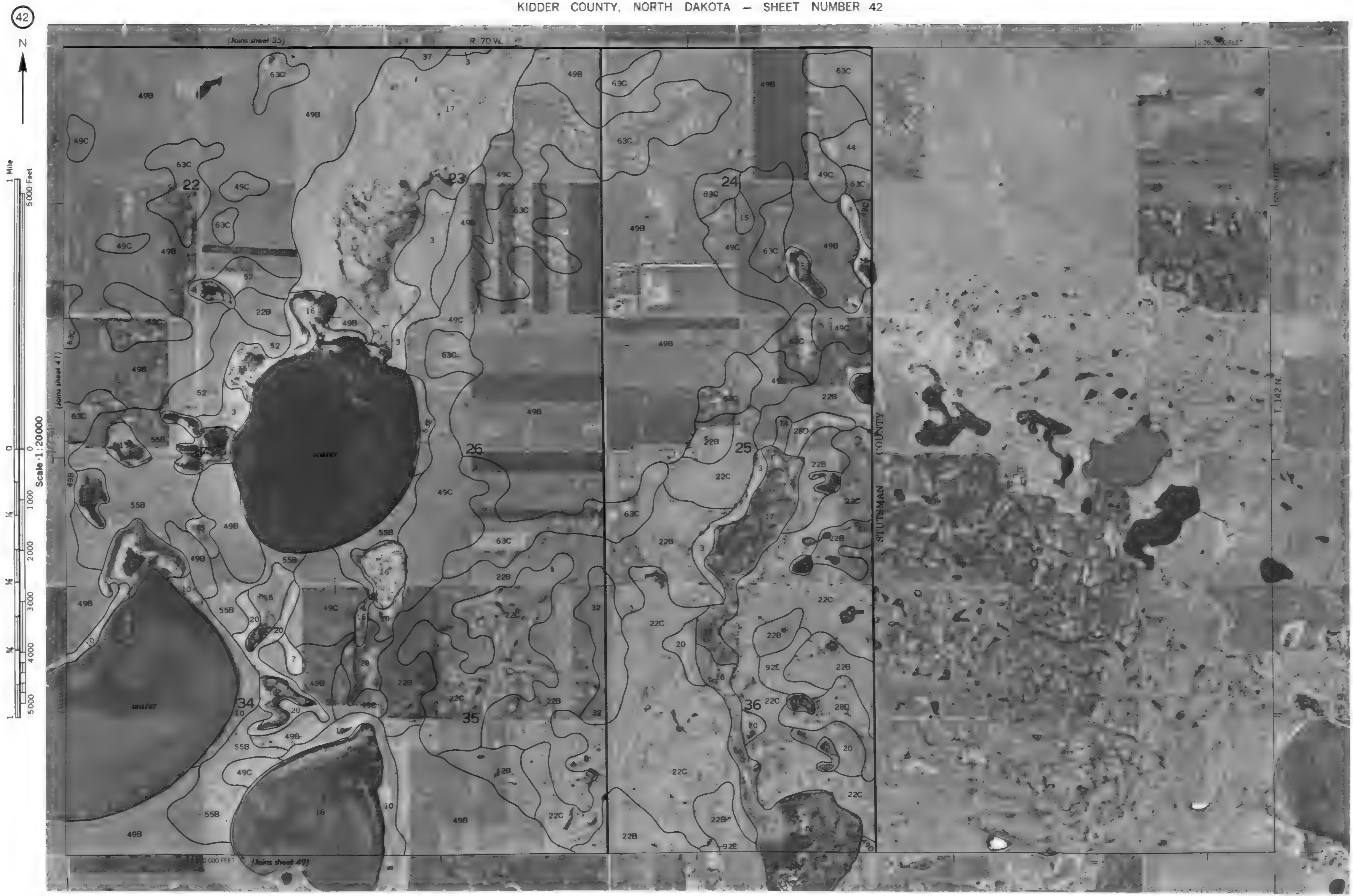


This map is compiled on 1976 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



KIDDER COUNTY, NORTH DAKOTA NO. 41

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

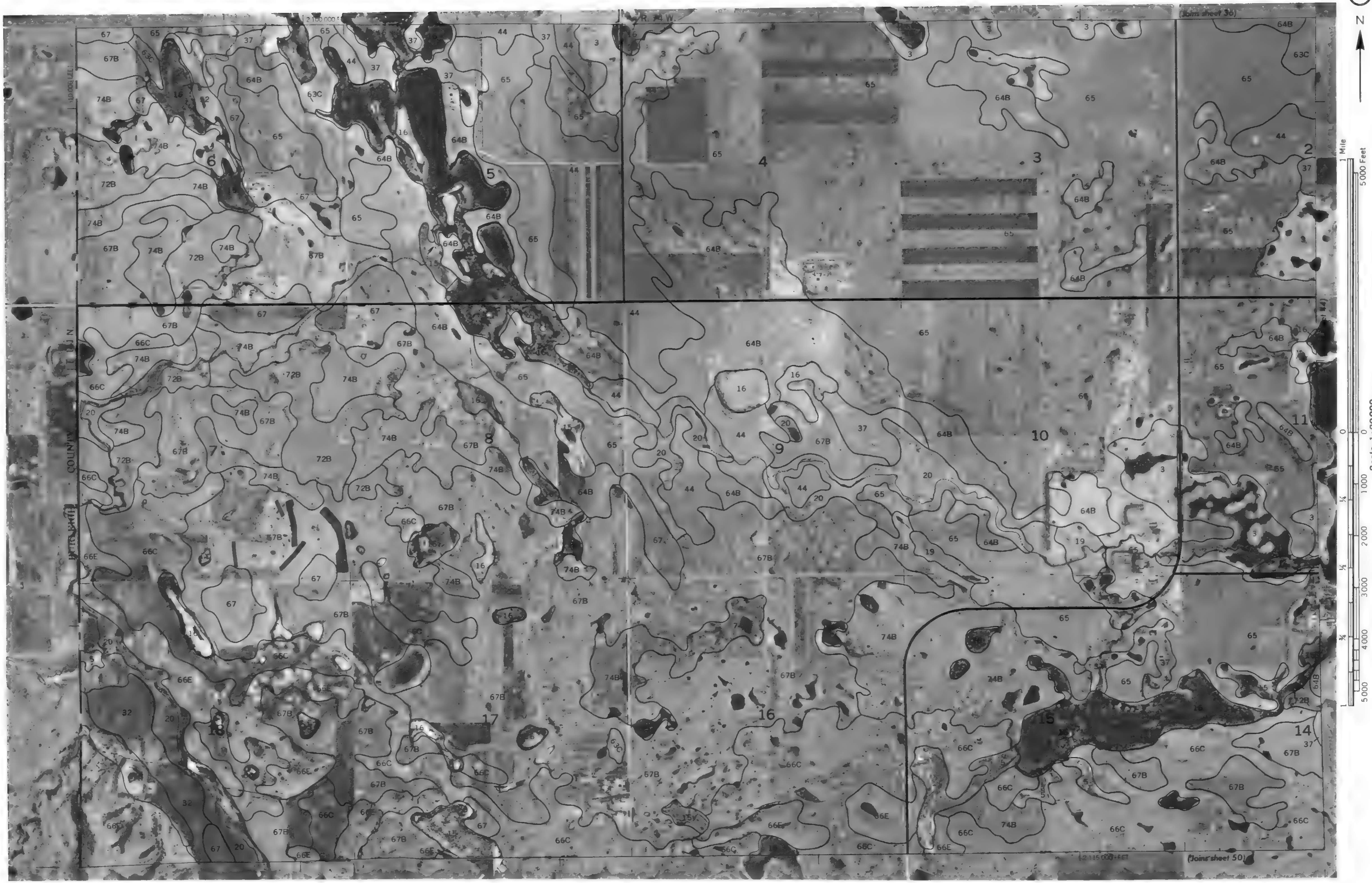


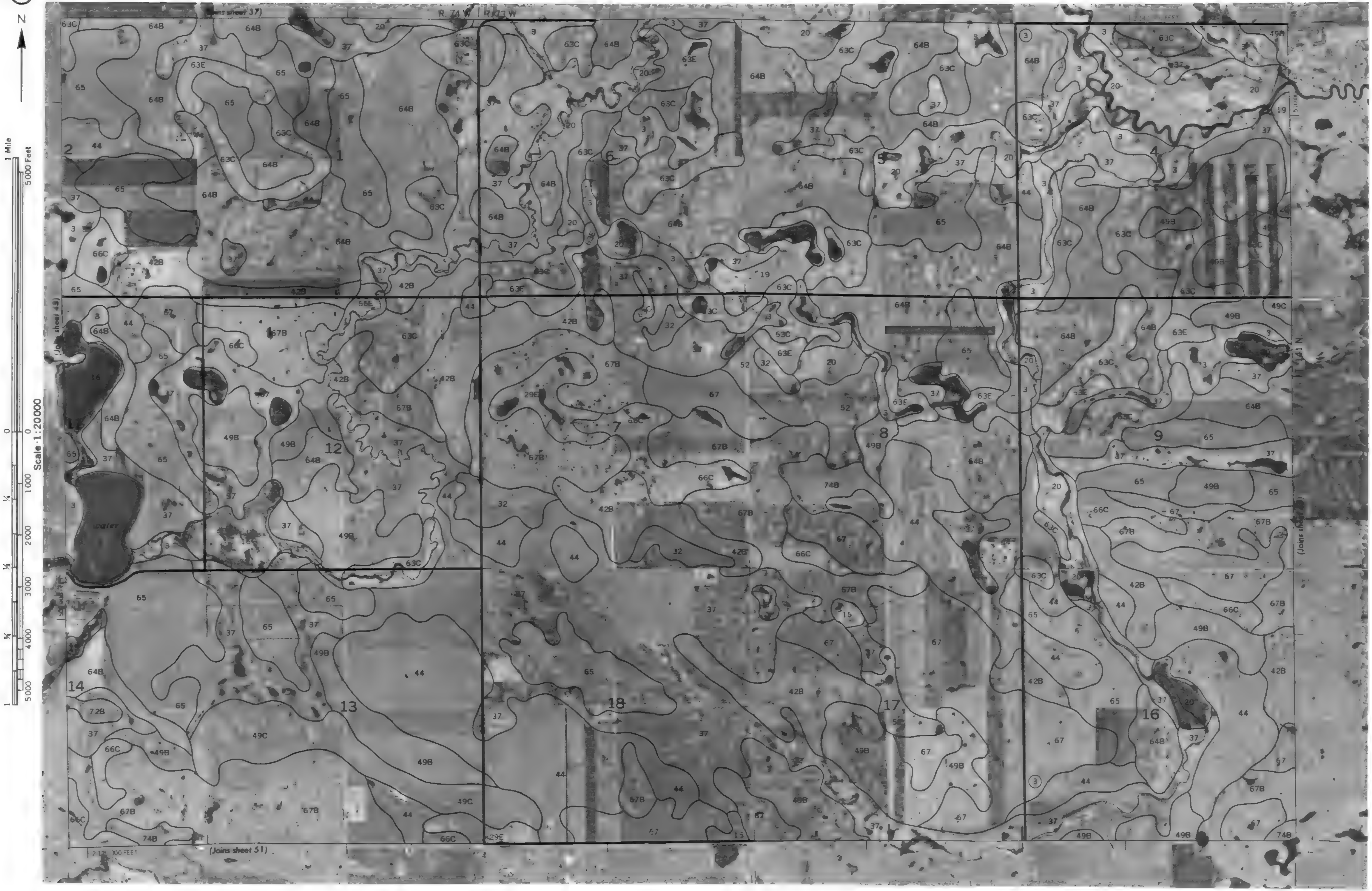
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned

43

KIDDER COUNTY, NORTH DAKOTA NO. 43

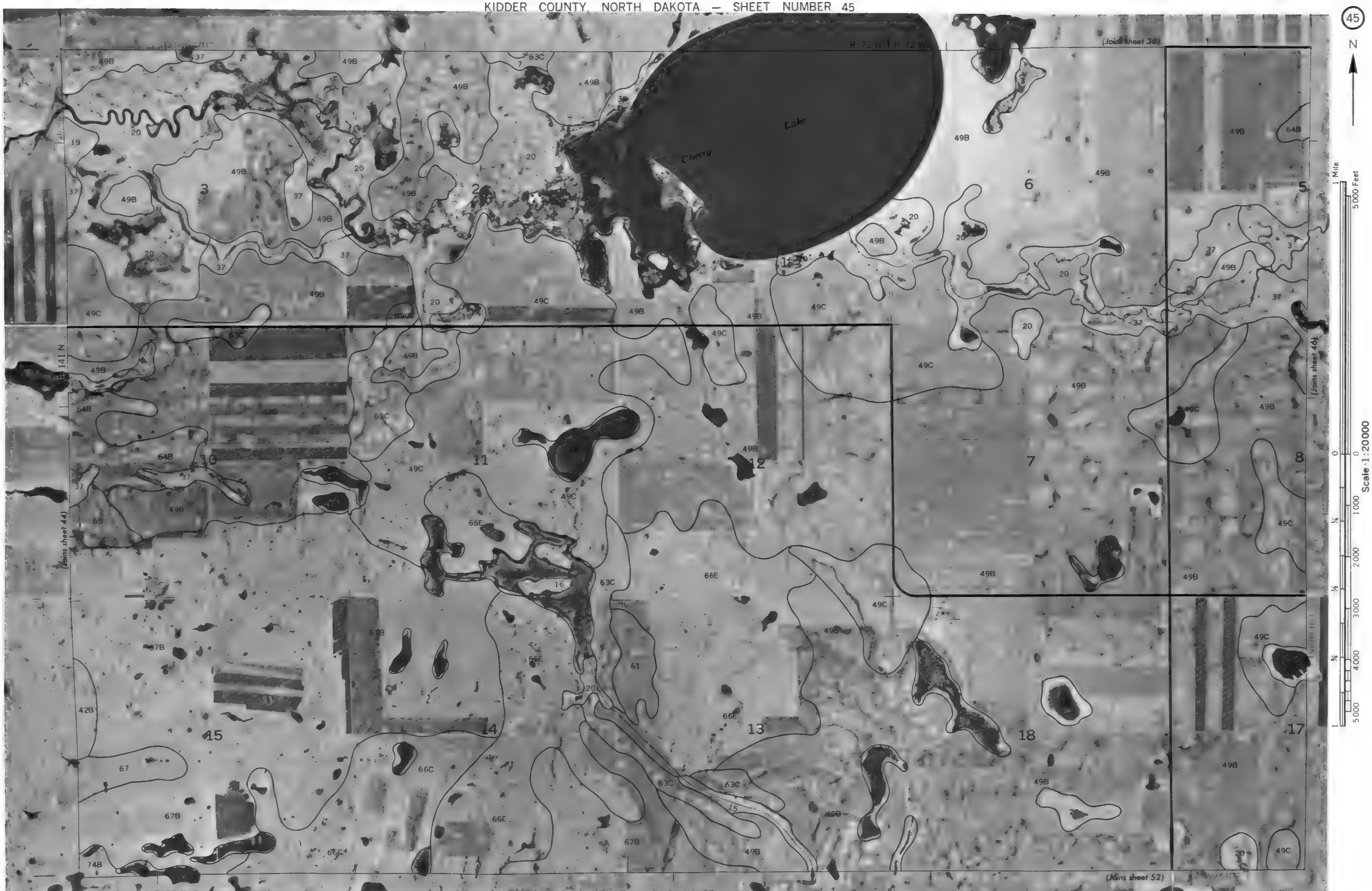
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.





This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

KIDDER COUNTY, NORTH DAKOTA — SHEET NUMBER 45



KIDDER COUNTY, NORTH DAKOTA NO. 45

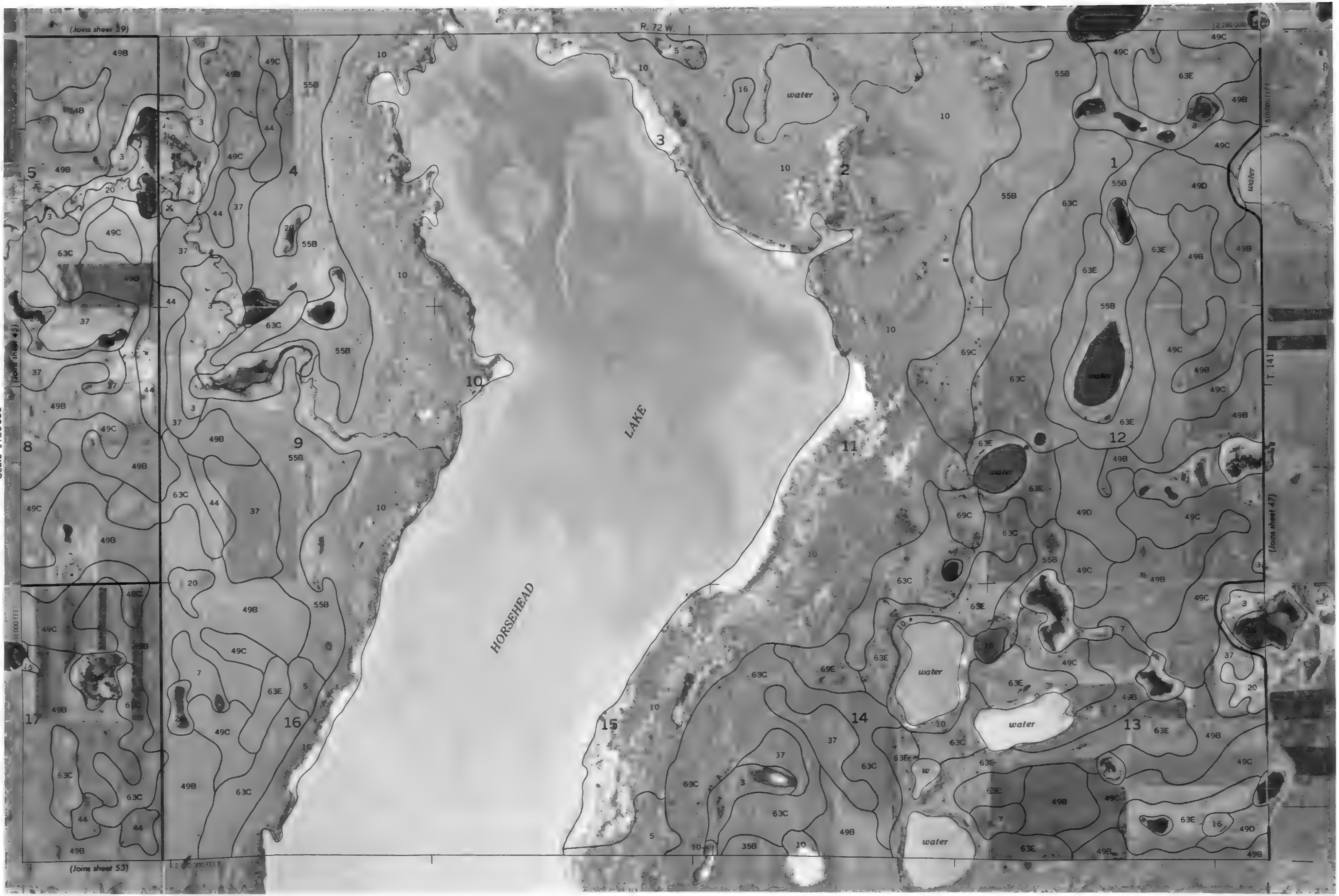
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned

N

1 Mile

5000 Feet

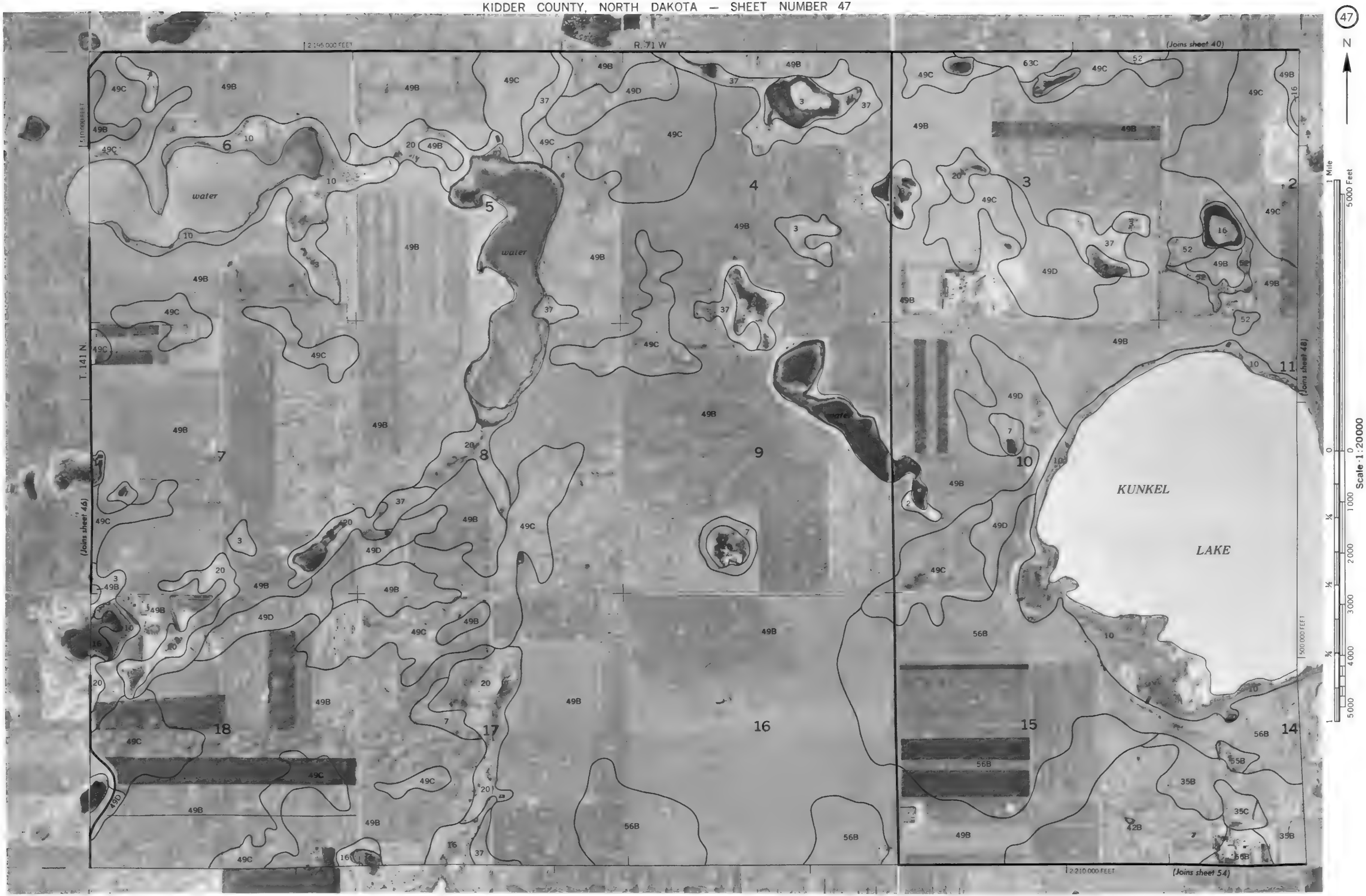
Scale 1:20000

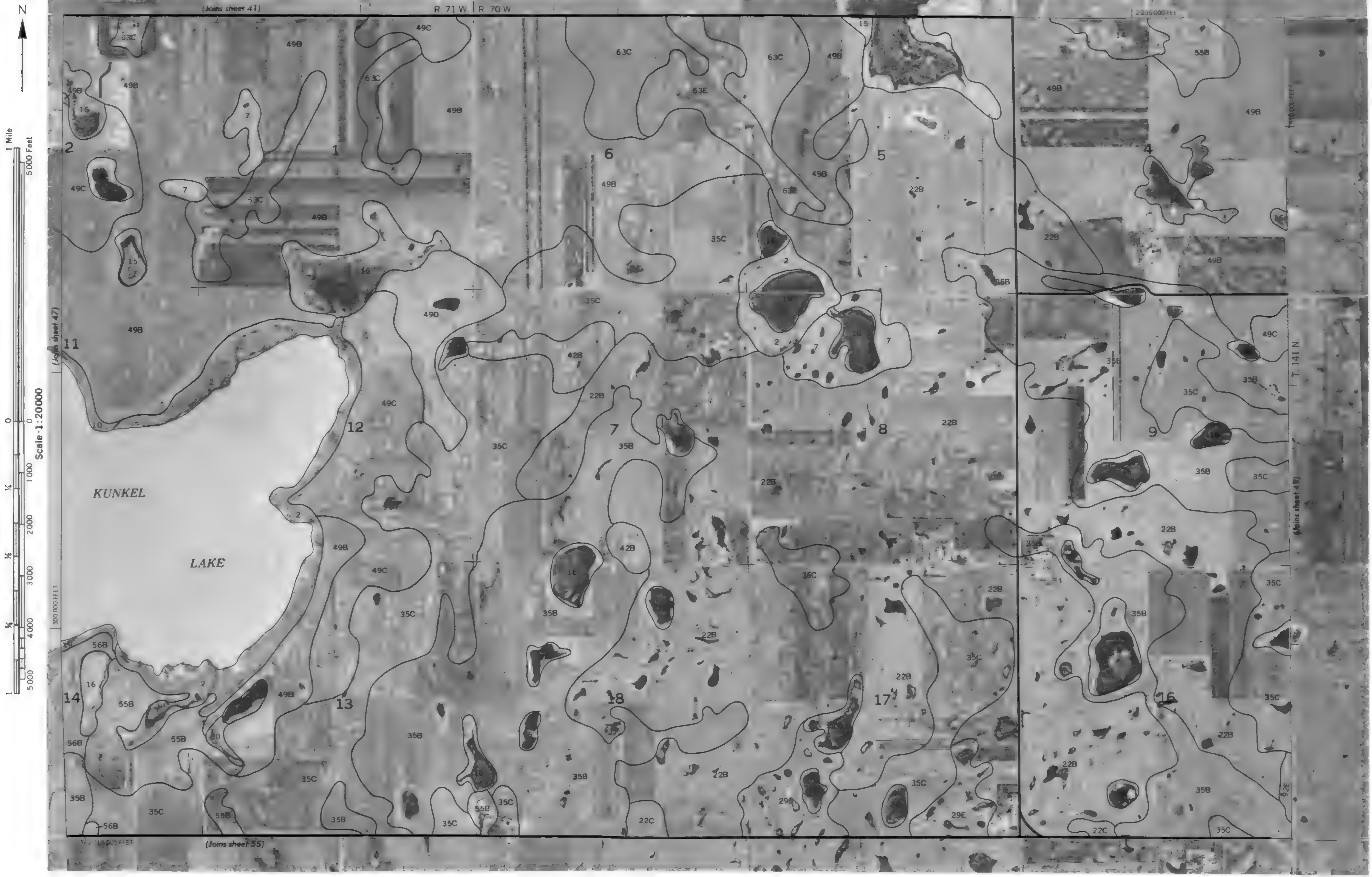


This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

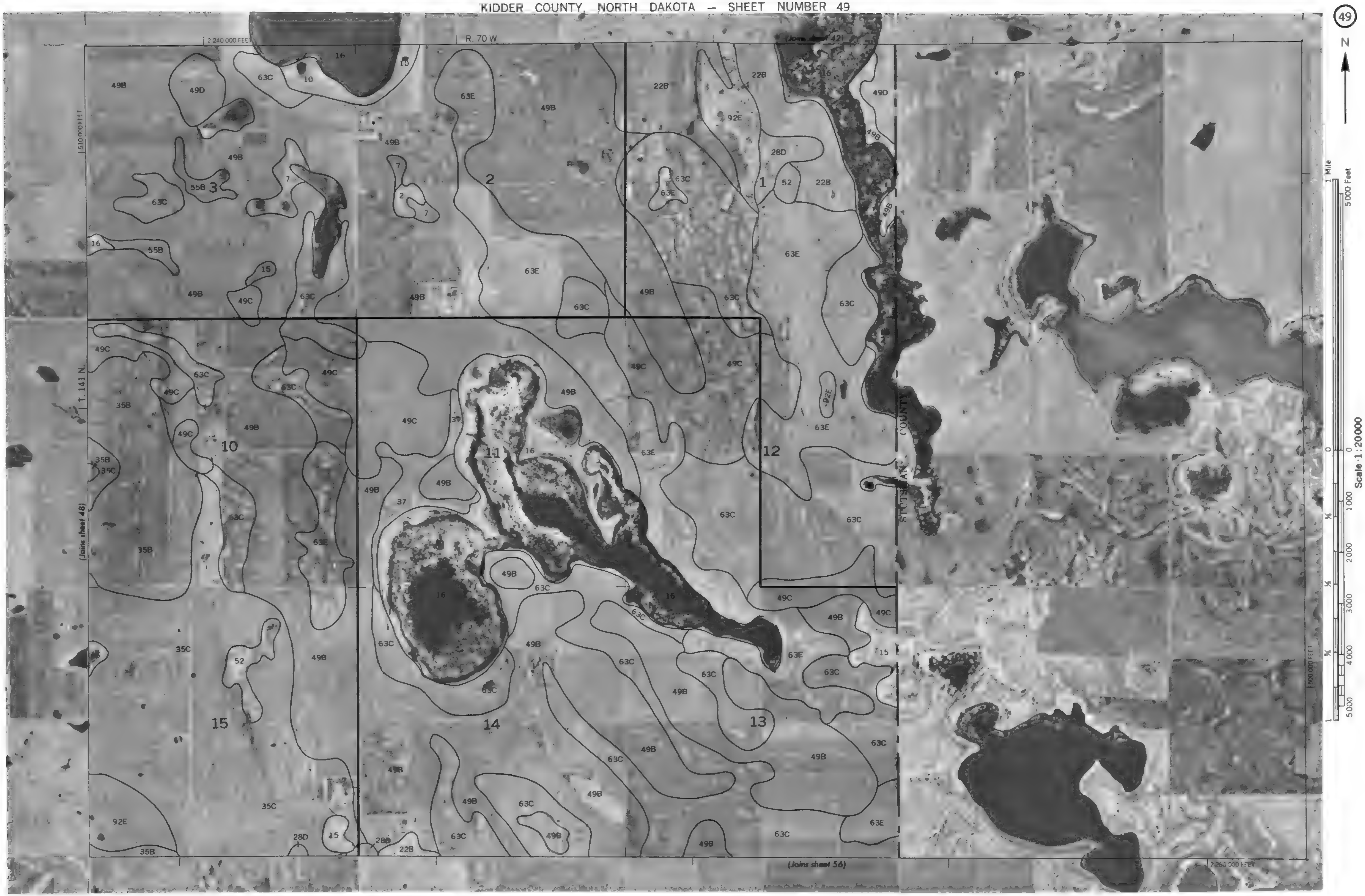
KIDDER COUNTY, NORTH DAKOTA NO. 47

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned



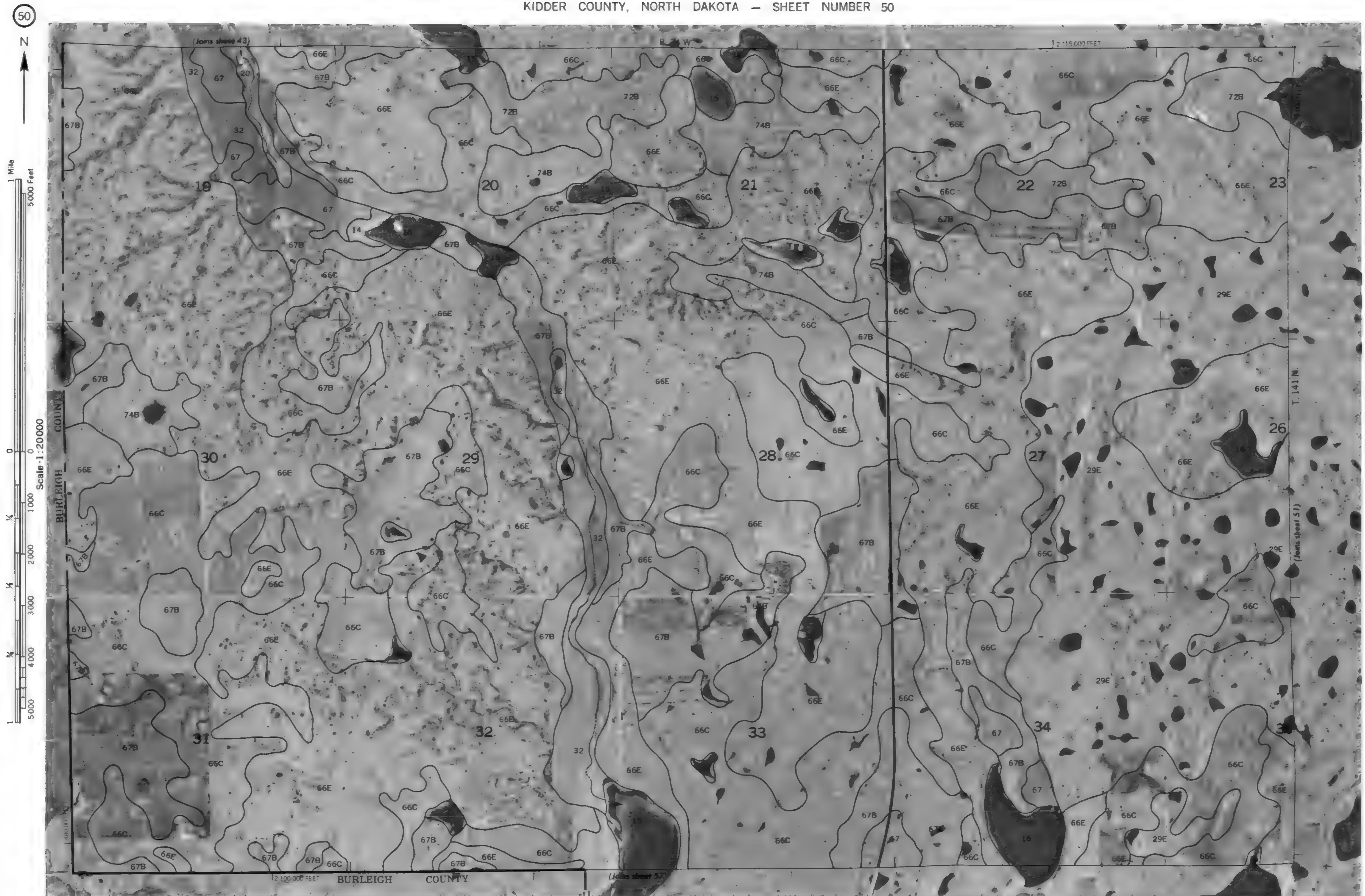


This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

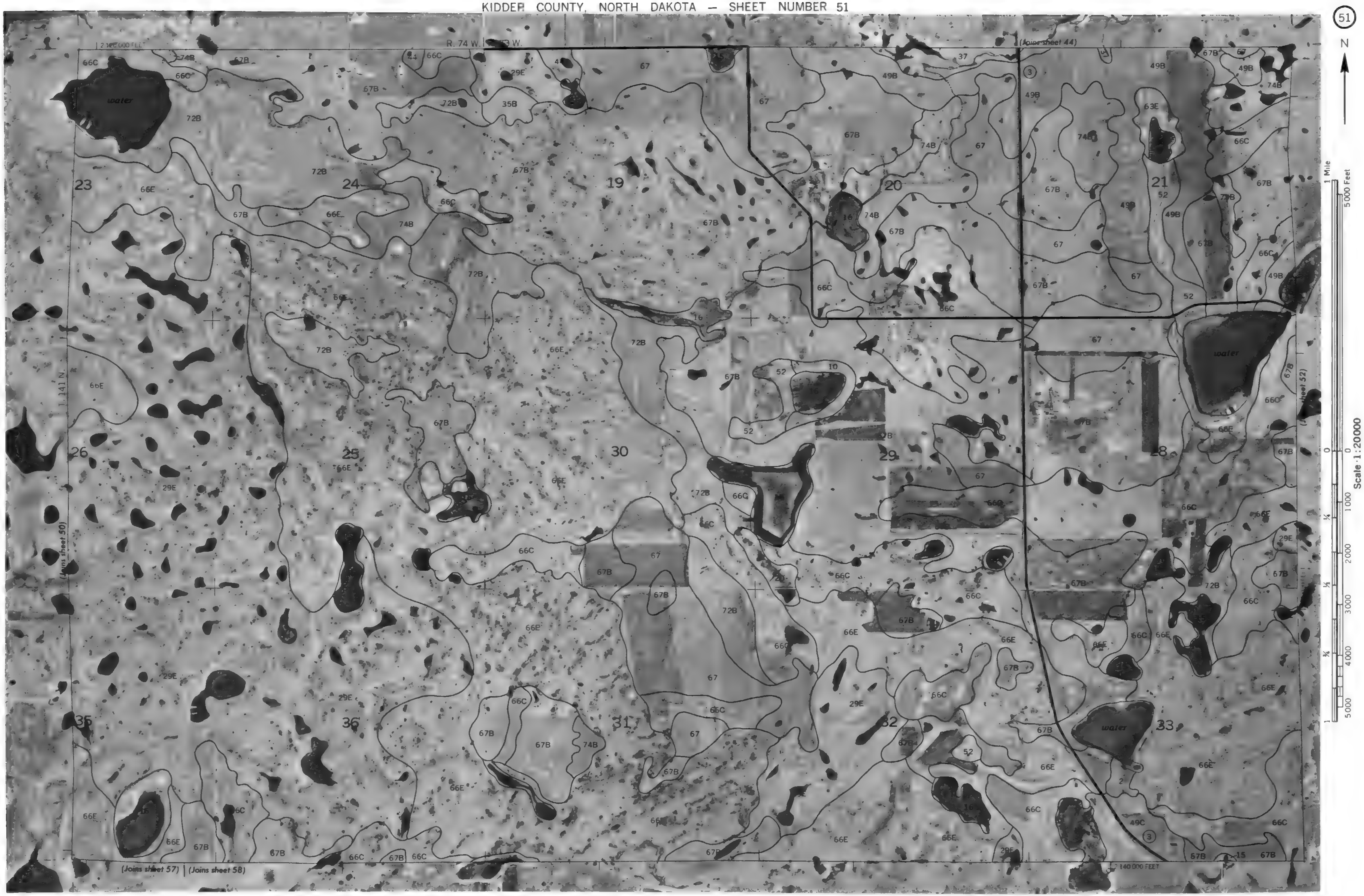


KIDDER COUNTY, NORTH DAKOTA NO. 49

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

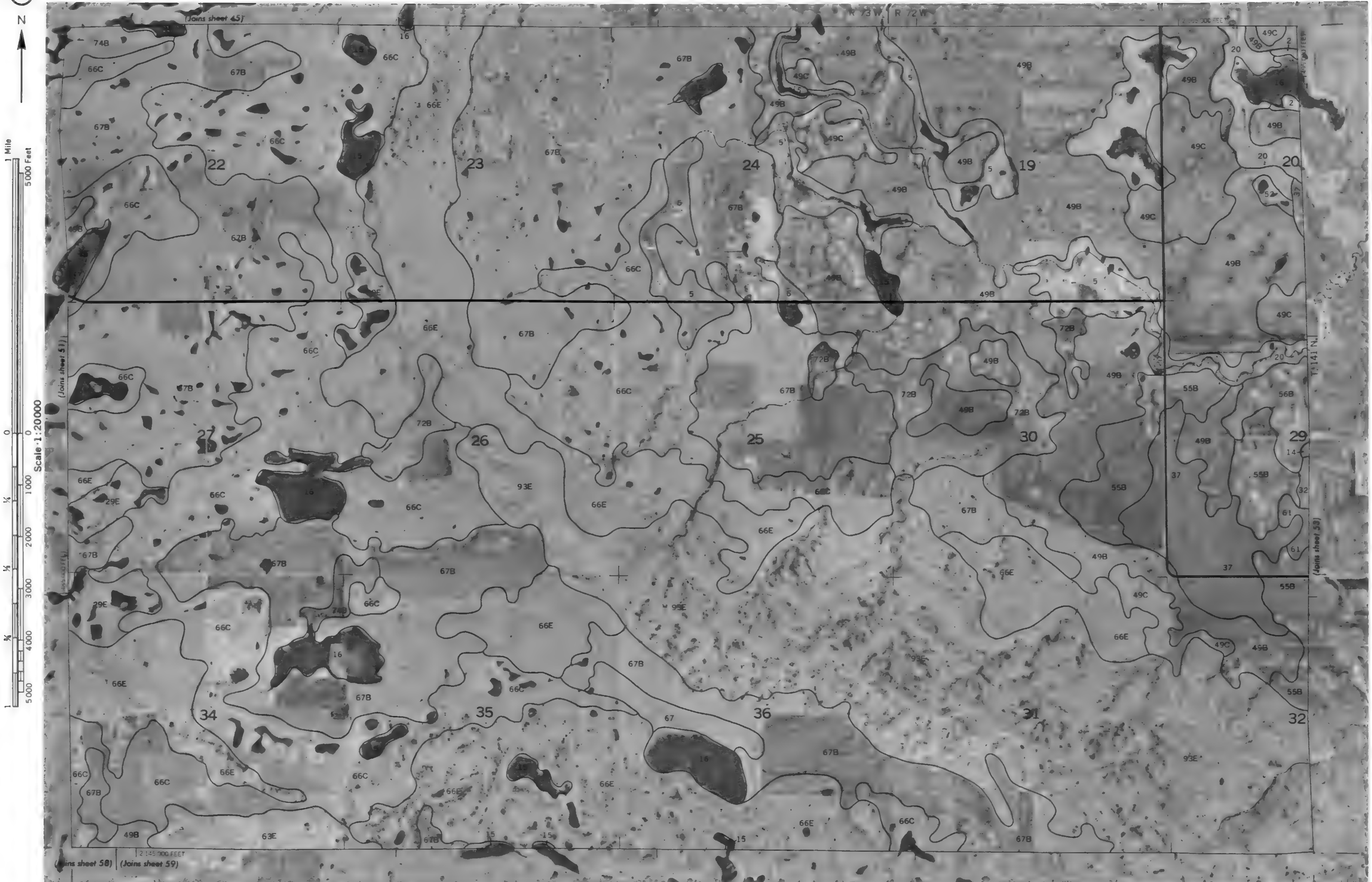


This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



KIDDER COUNTY, NORTH DAKOTA NO. 51

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

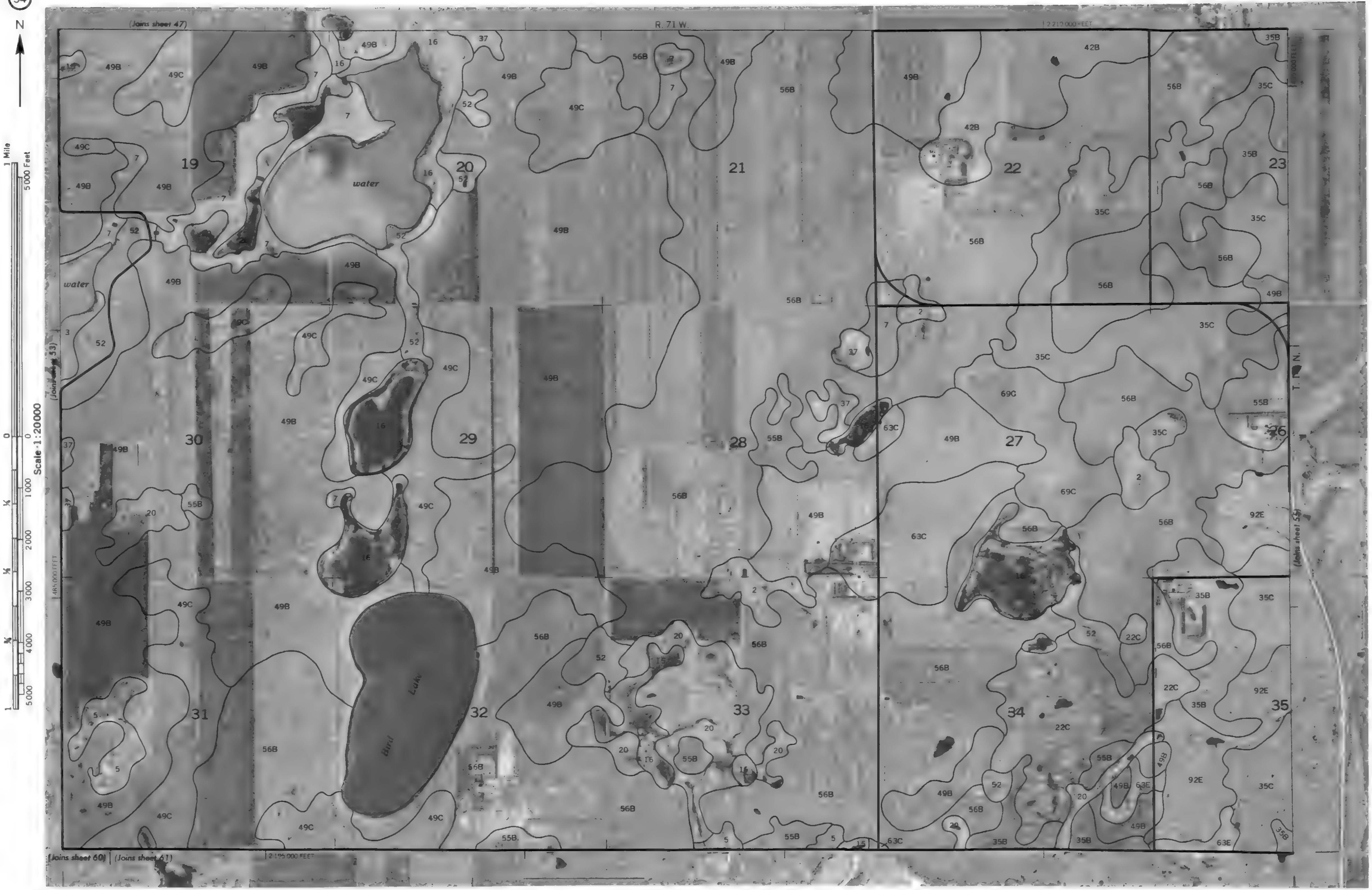


This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

KIDDER COUNTY, NORTH DAKOTA NO. 52

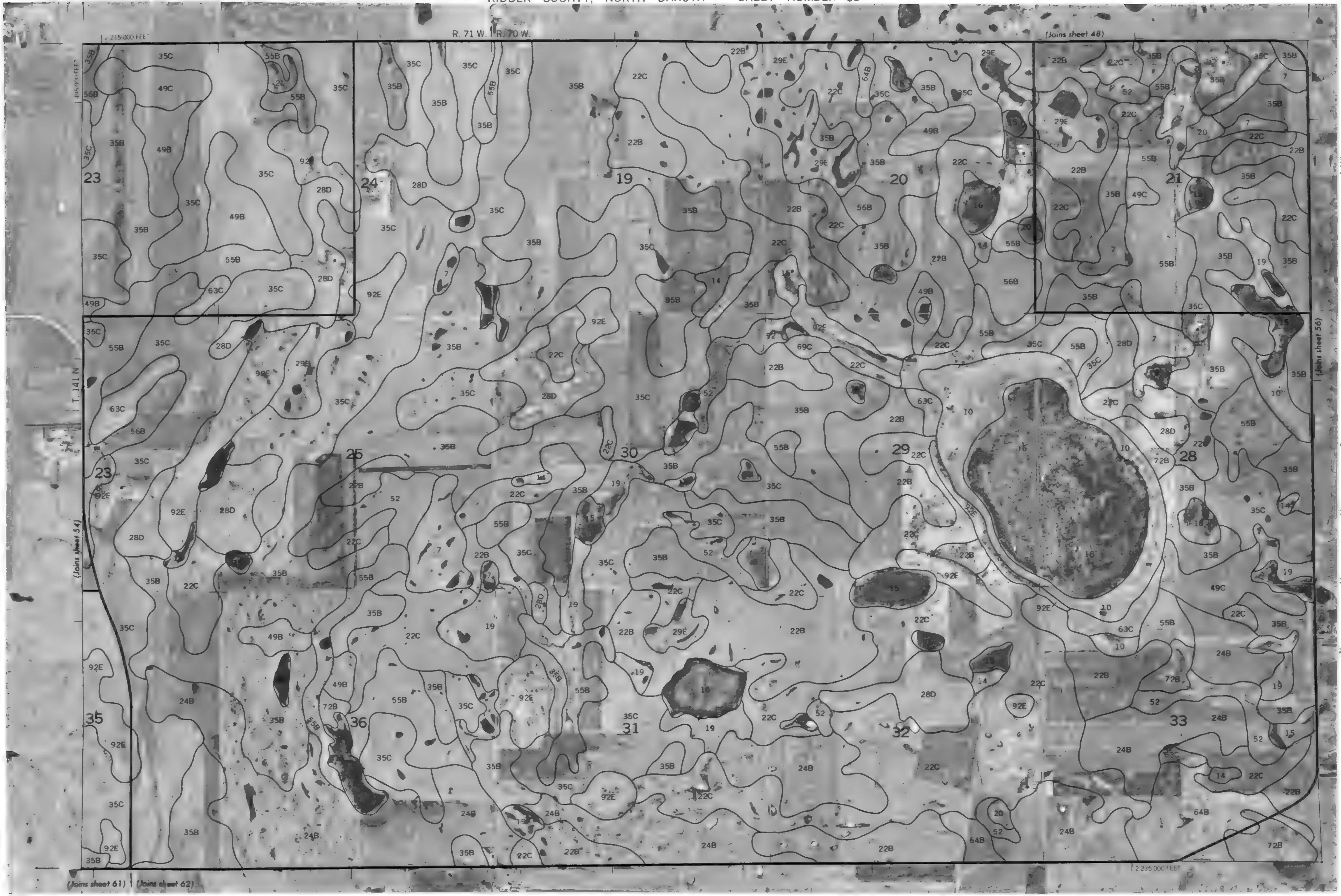
KIDDER COUNTY, NORTH DAKOTA NO. 53

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

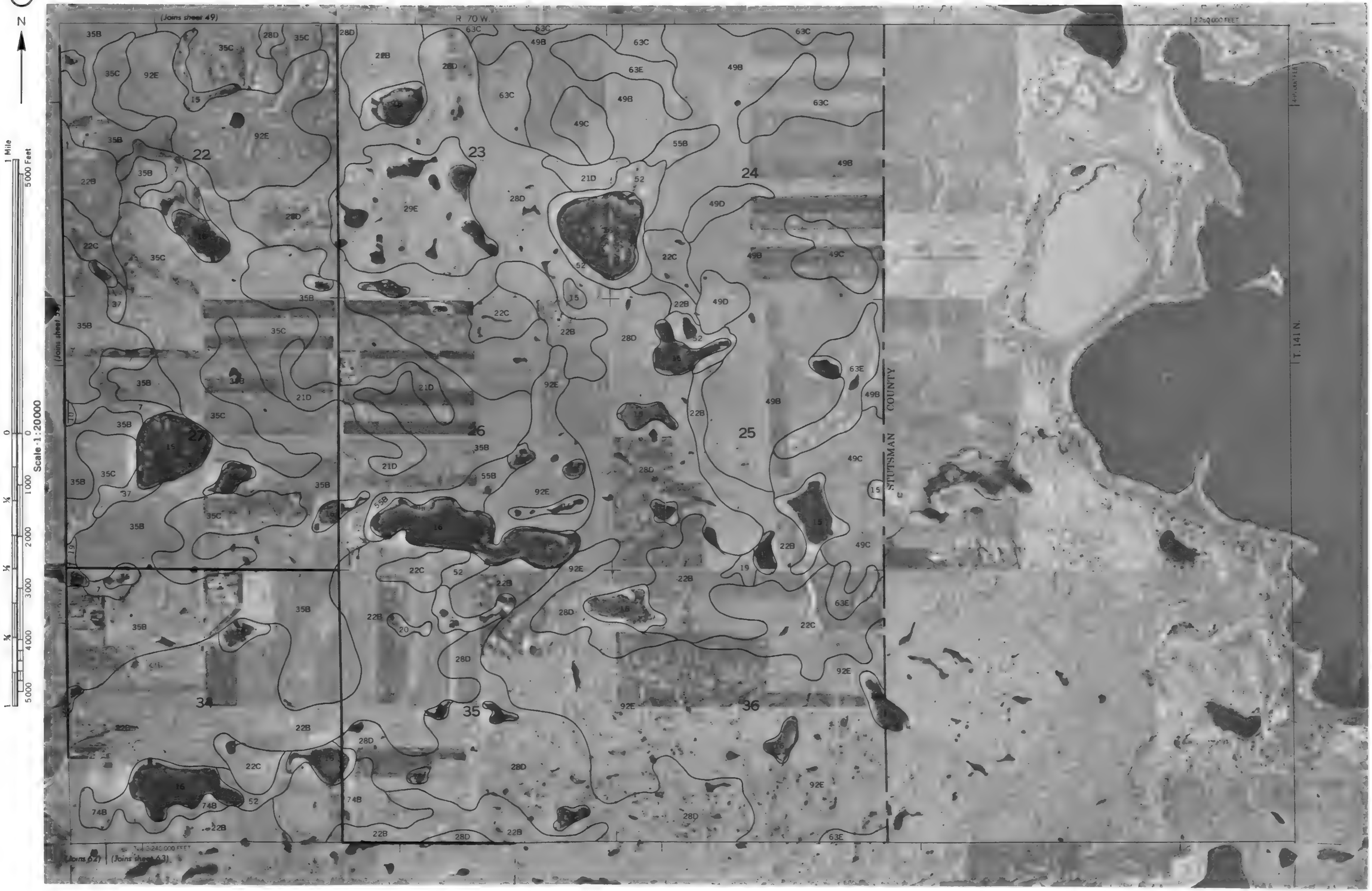
55



1 Mile
5000 Feet
Scale 1:20000

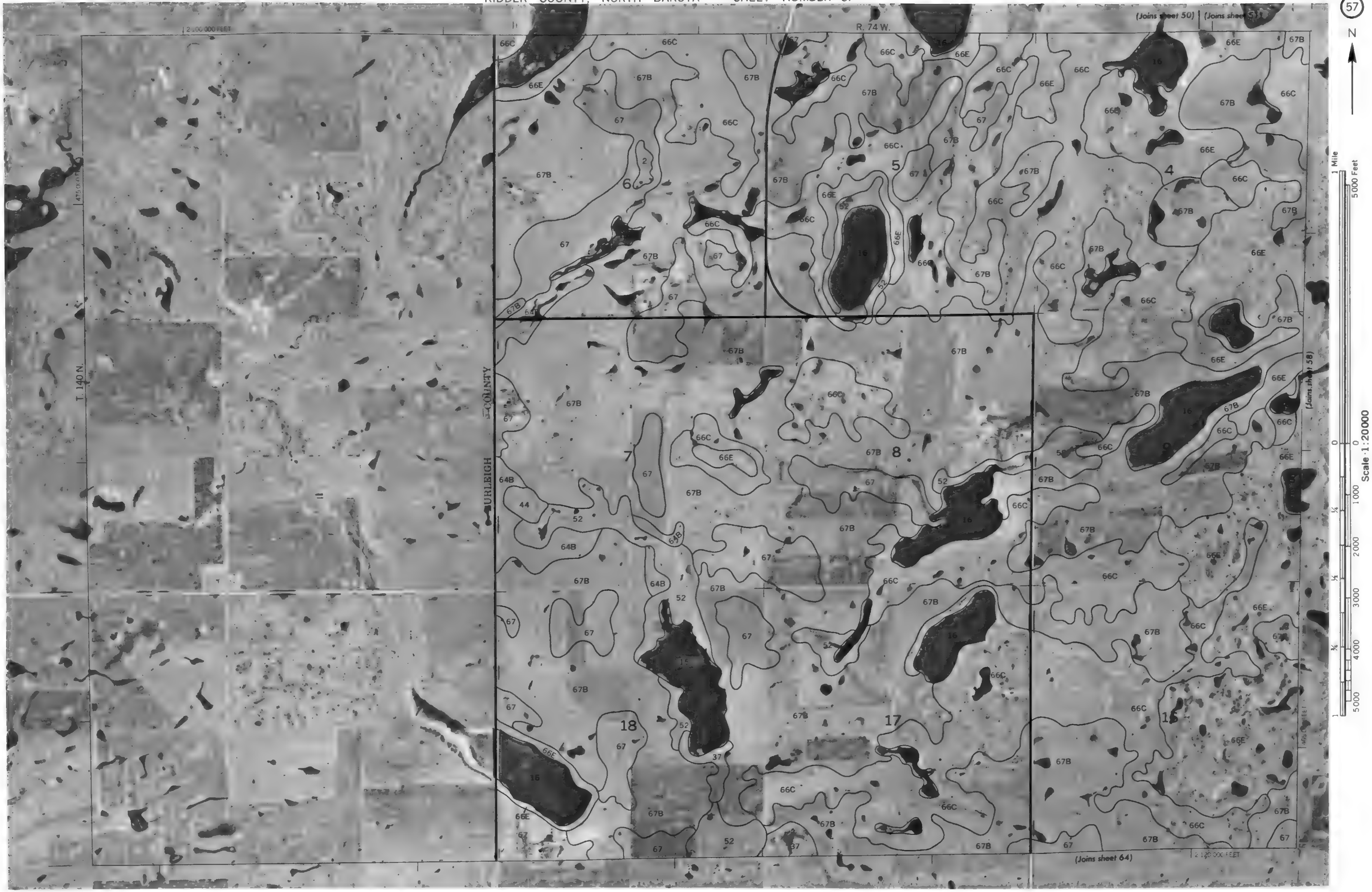
KIDDER COUNTY, NORTH DAKOTA NO. 55

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

KIDDER COUNTY, NORTH DAKOTA NO. 56



KIDDER COUNTY, NORTH DAKOTA NO. 57

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned

N

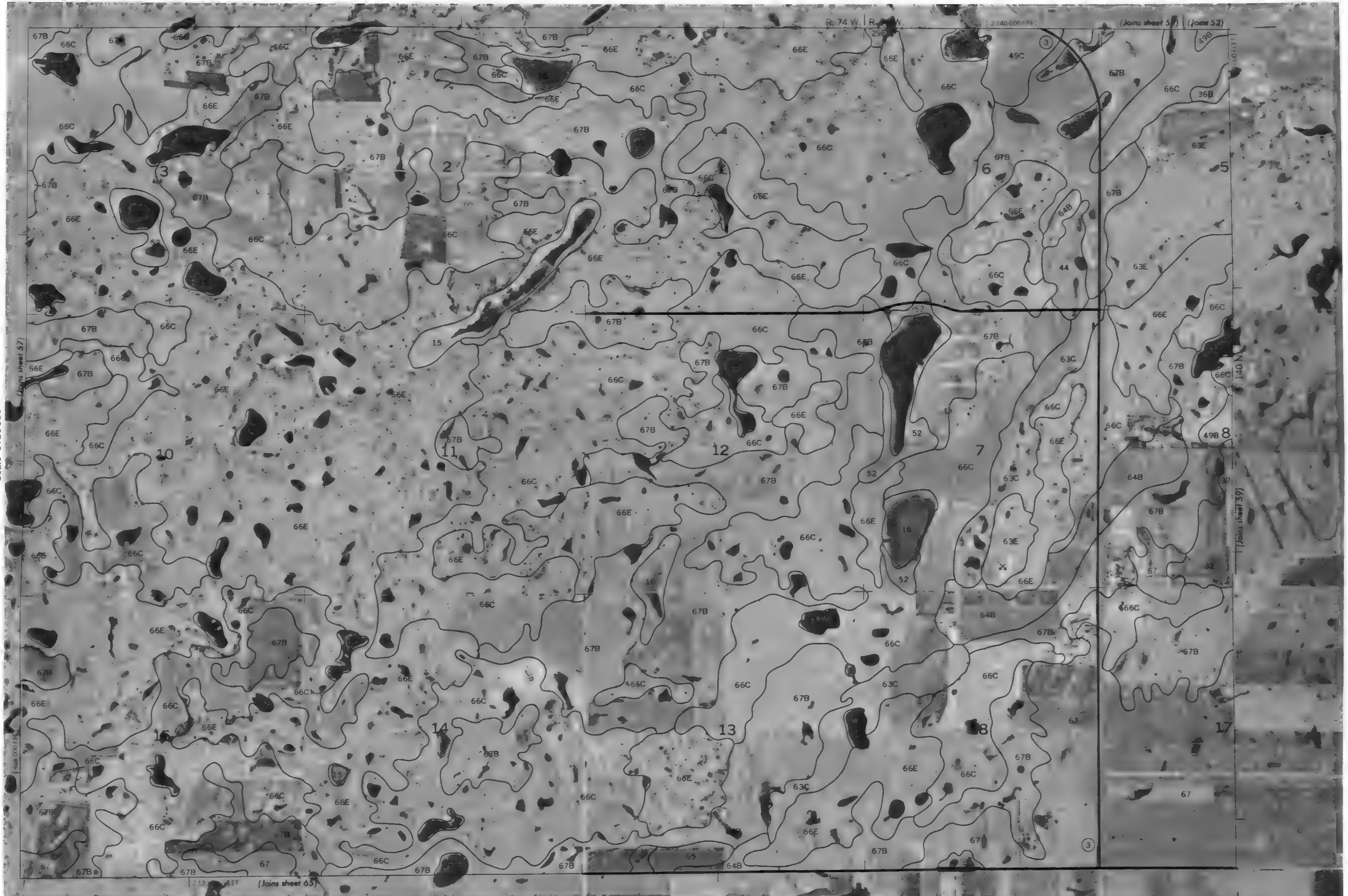
1 Mile

5000 Feet

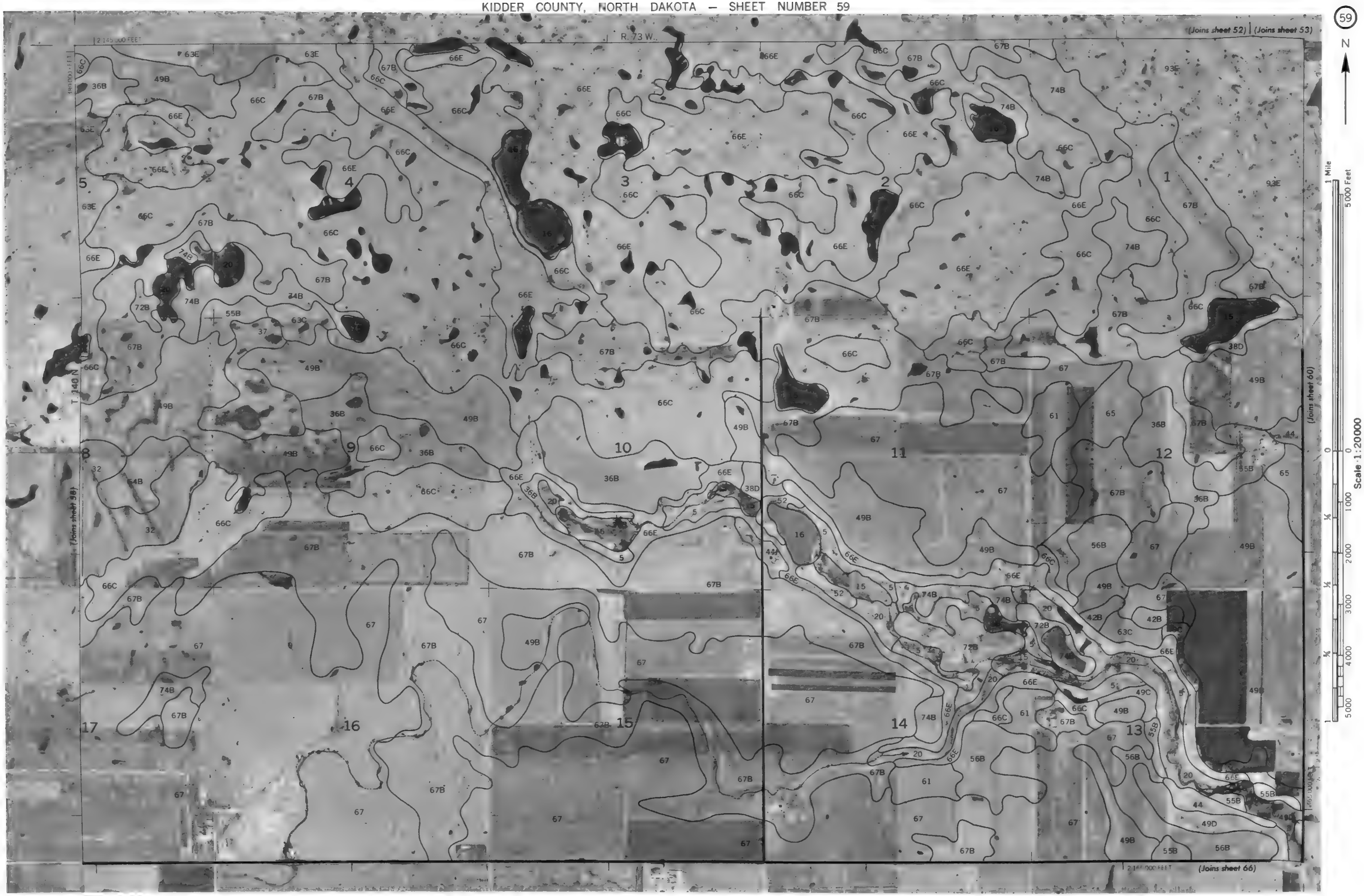
Scale 1:20000

0 ¼ ½ ¾ 1

0 1000 2000 3000 4000 5000

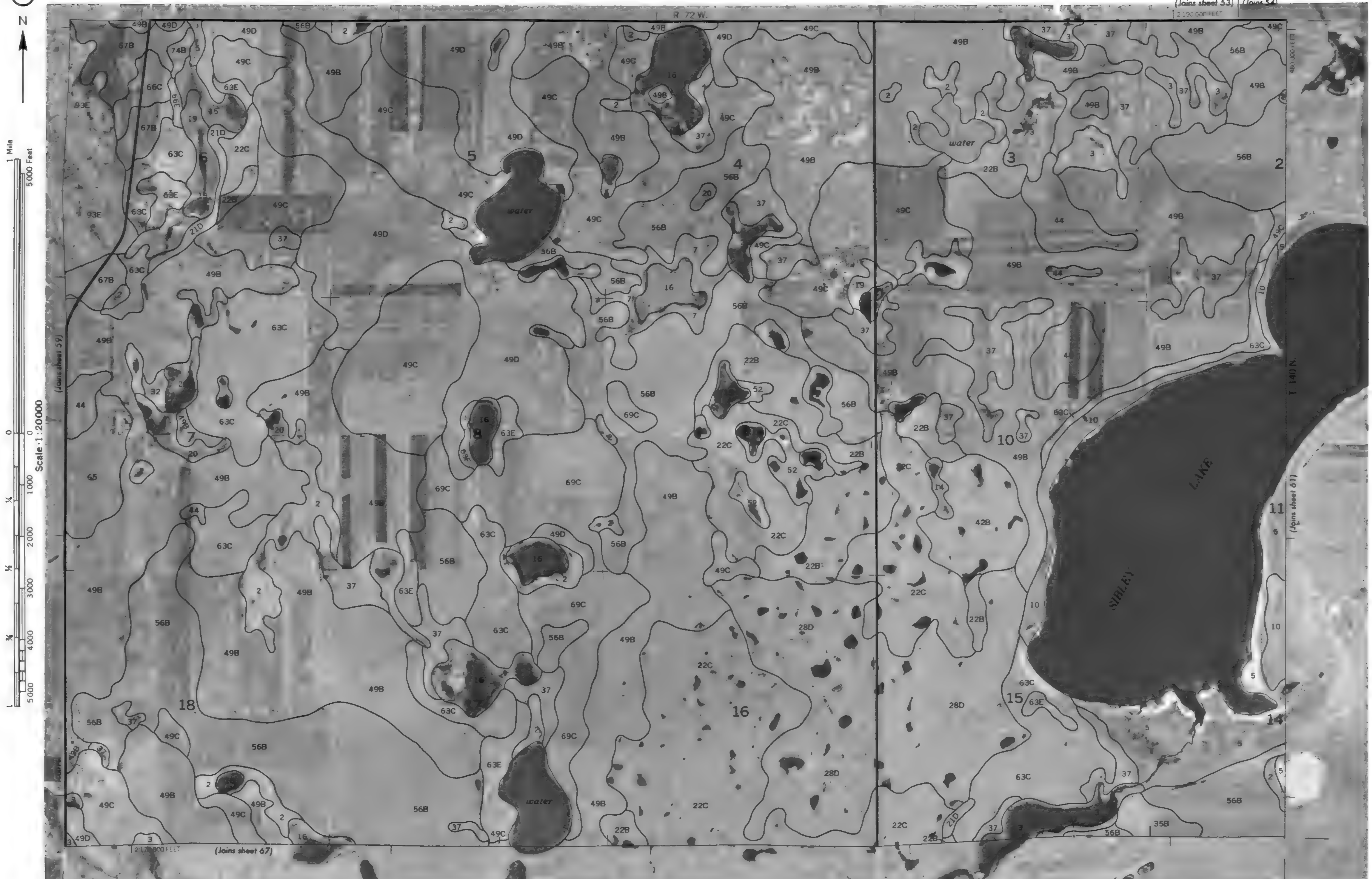


This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



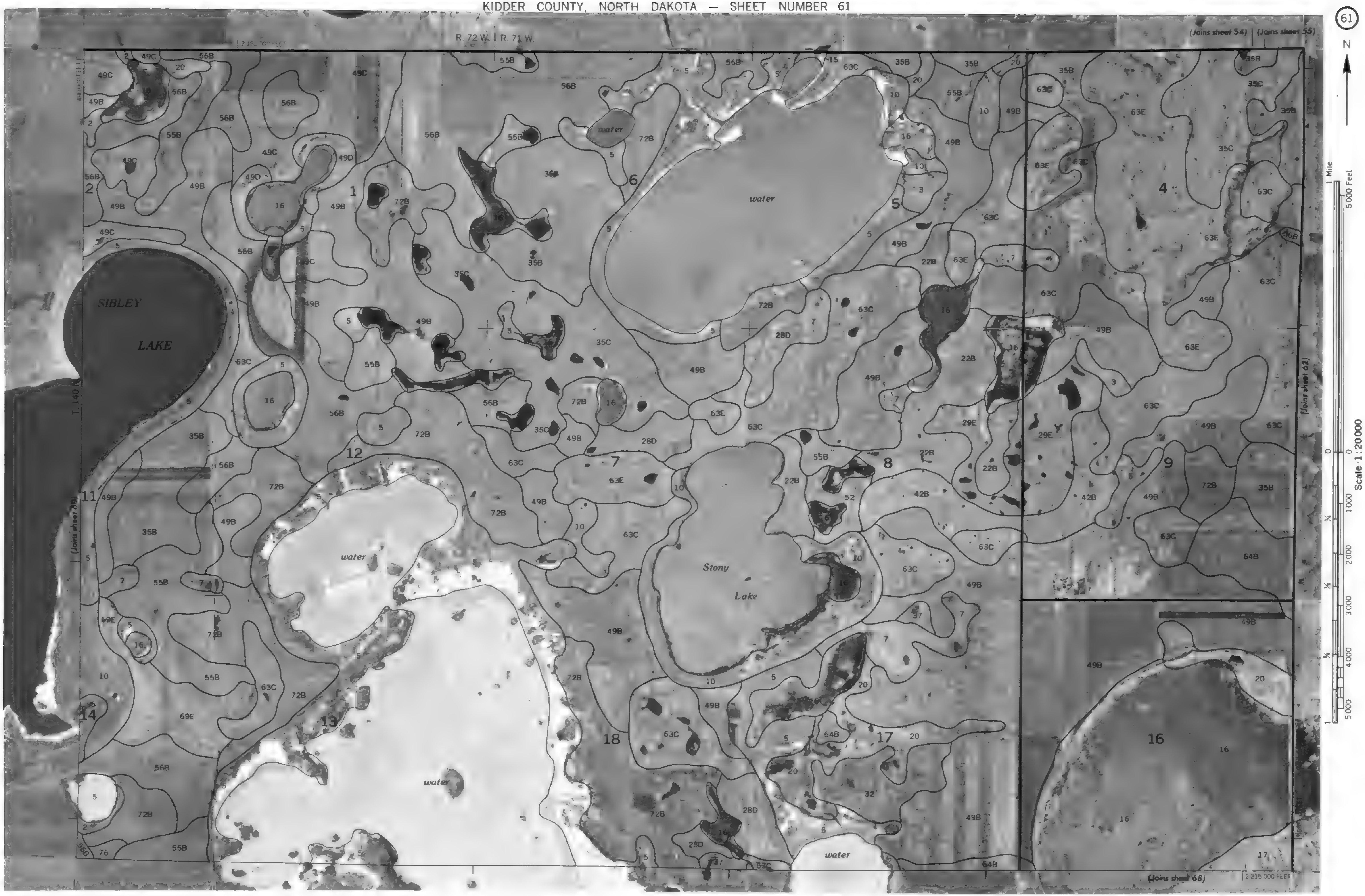
KIDDER COUNTY, NORTH DAKOTA NO. 59

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned

KIDDER COUNTY, NORTH DAKOTA NO. 60



KIDDER COUNTY, NORTH DAKOTA NO. 61

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

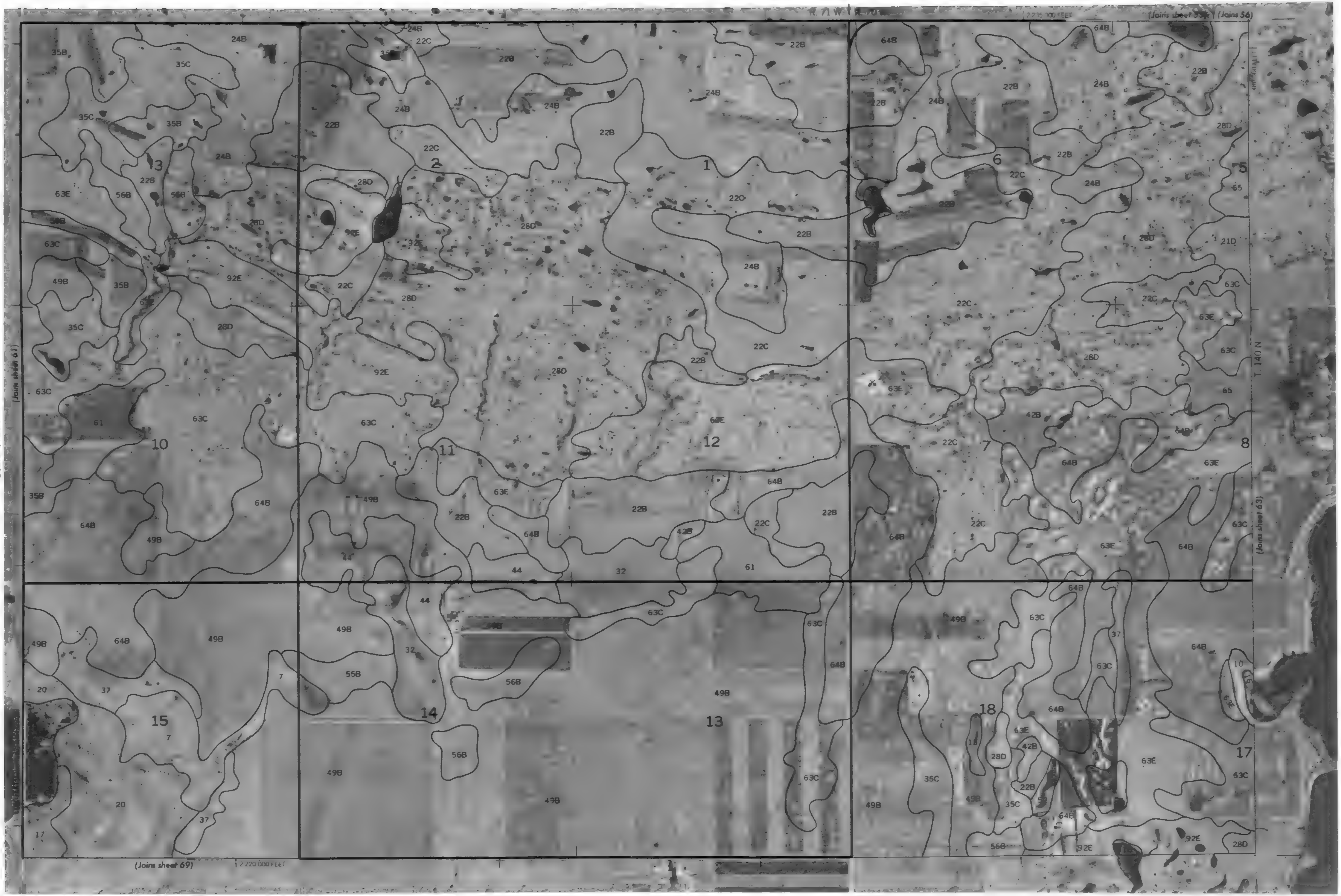
KIDDER COUNTY, NORTH DAKOTA — SHEET NUMBER 62

N

1 Mile
5000 Feet

Scale 1:20000

0 1000 2000 3000 4000 5000

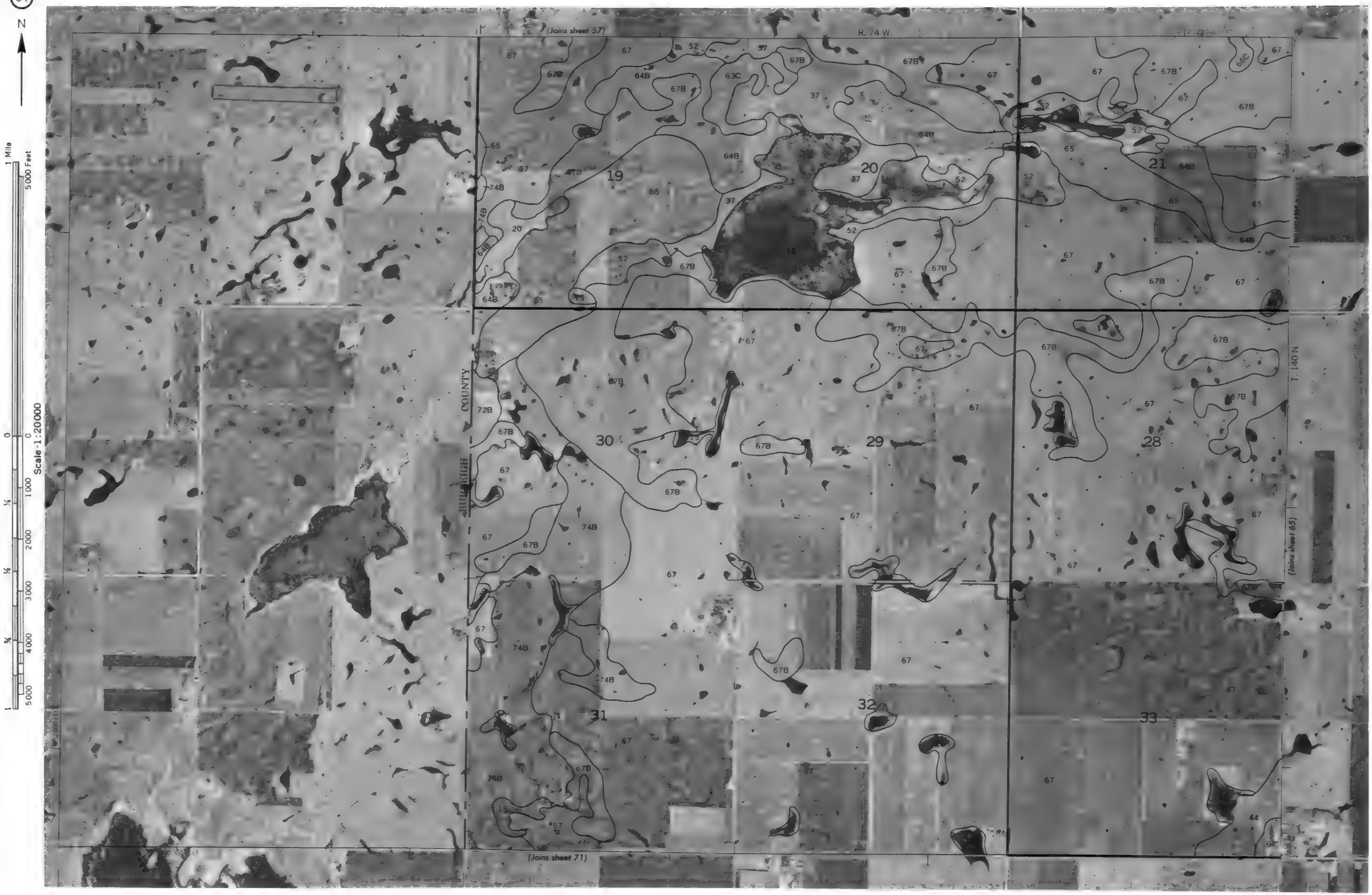


This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

KIDDER COUNTY, NORTH DAKOTA NO. 62

KIDDER COUNTY, NORTH DAKOTA NO. 63

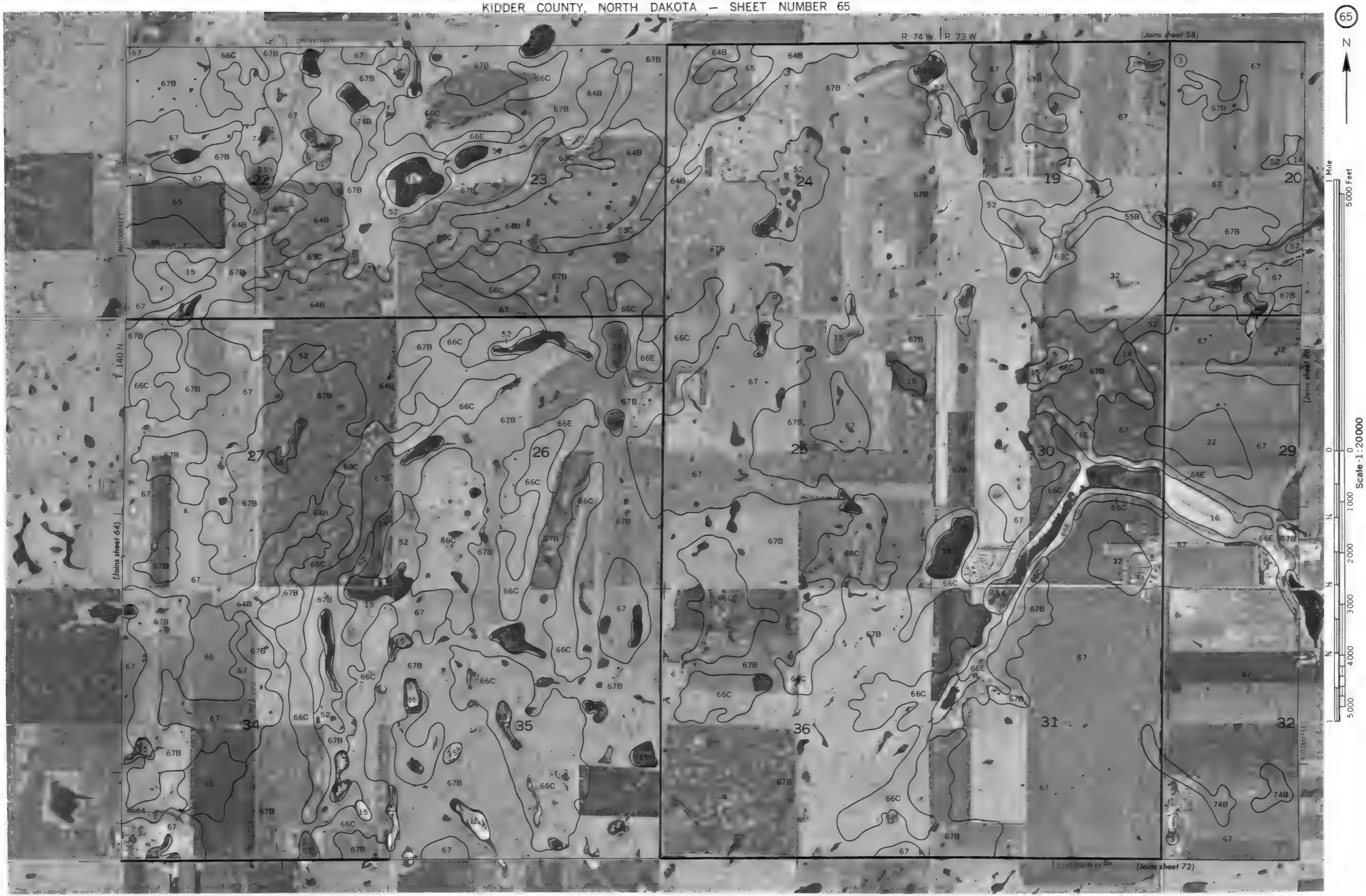
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned

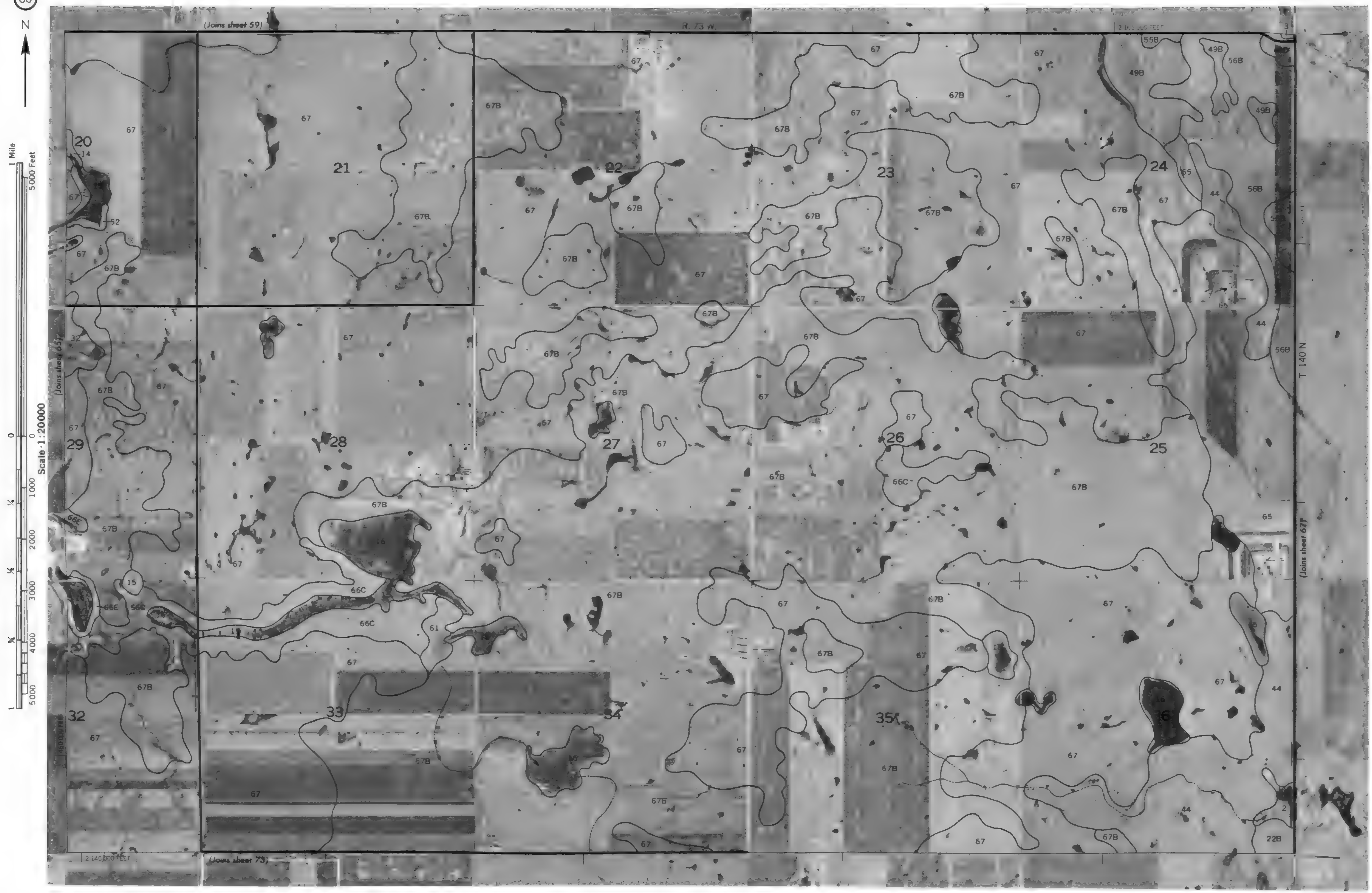


This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

KIDDER COUNTY, NORTH DAKOTA NO. 65

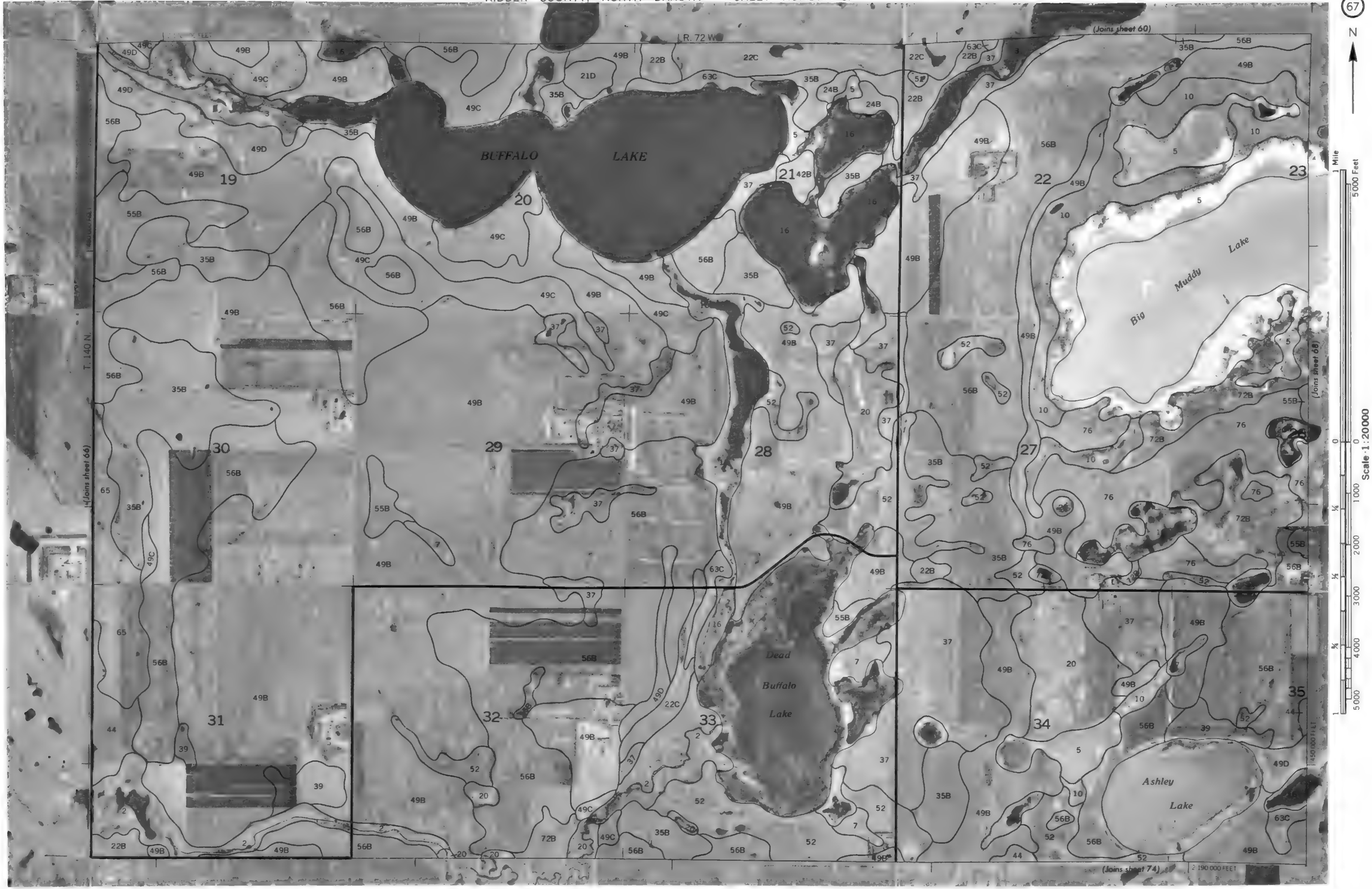
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.





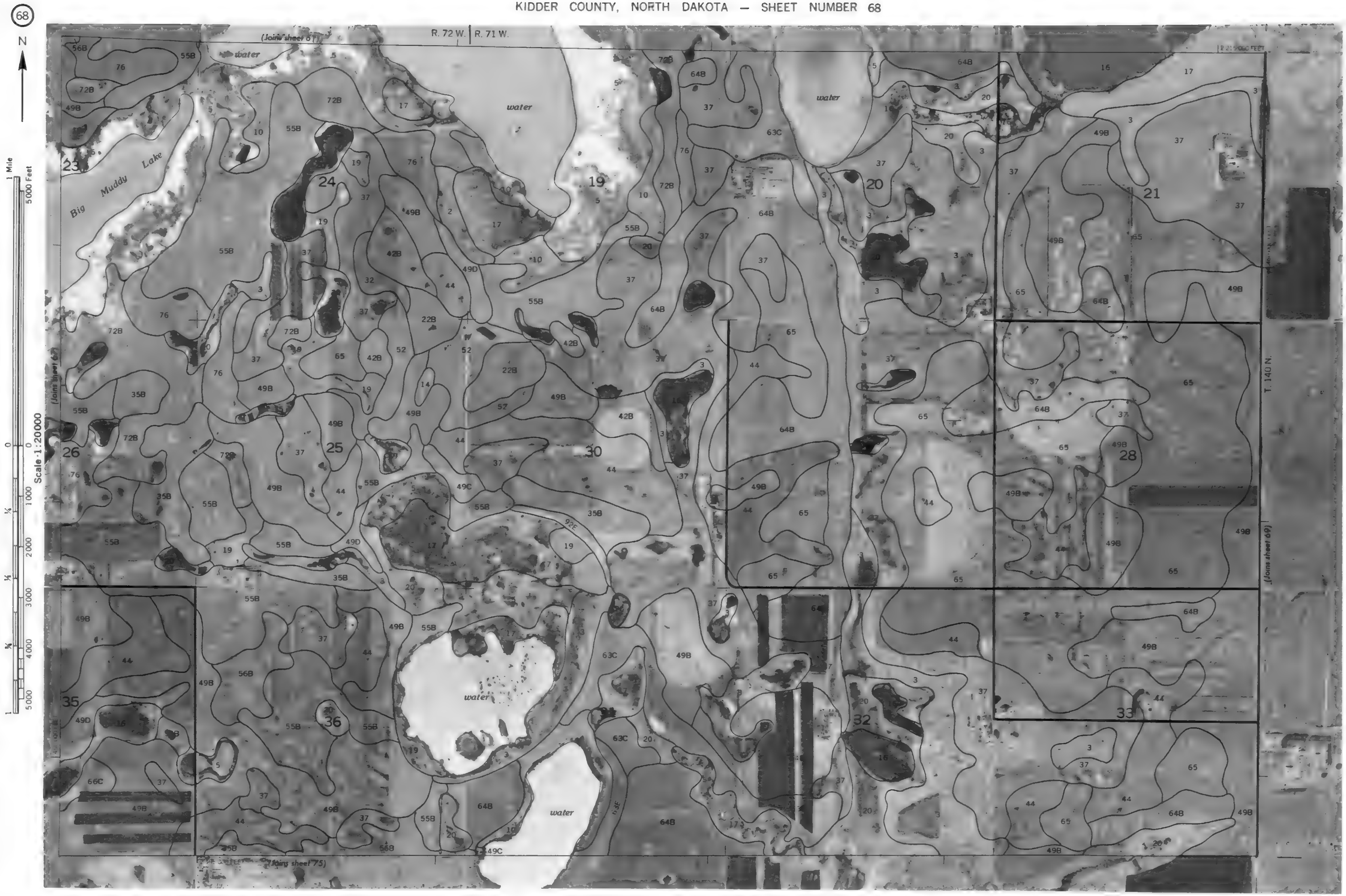
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned

KIDDER COUNTY, NORTH DAKOTA NO. 66



KIDDER COUNTY, NORTH DAKOTA NO. 67

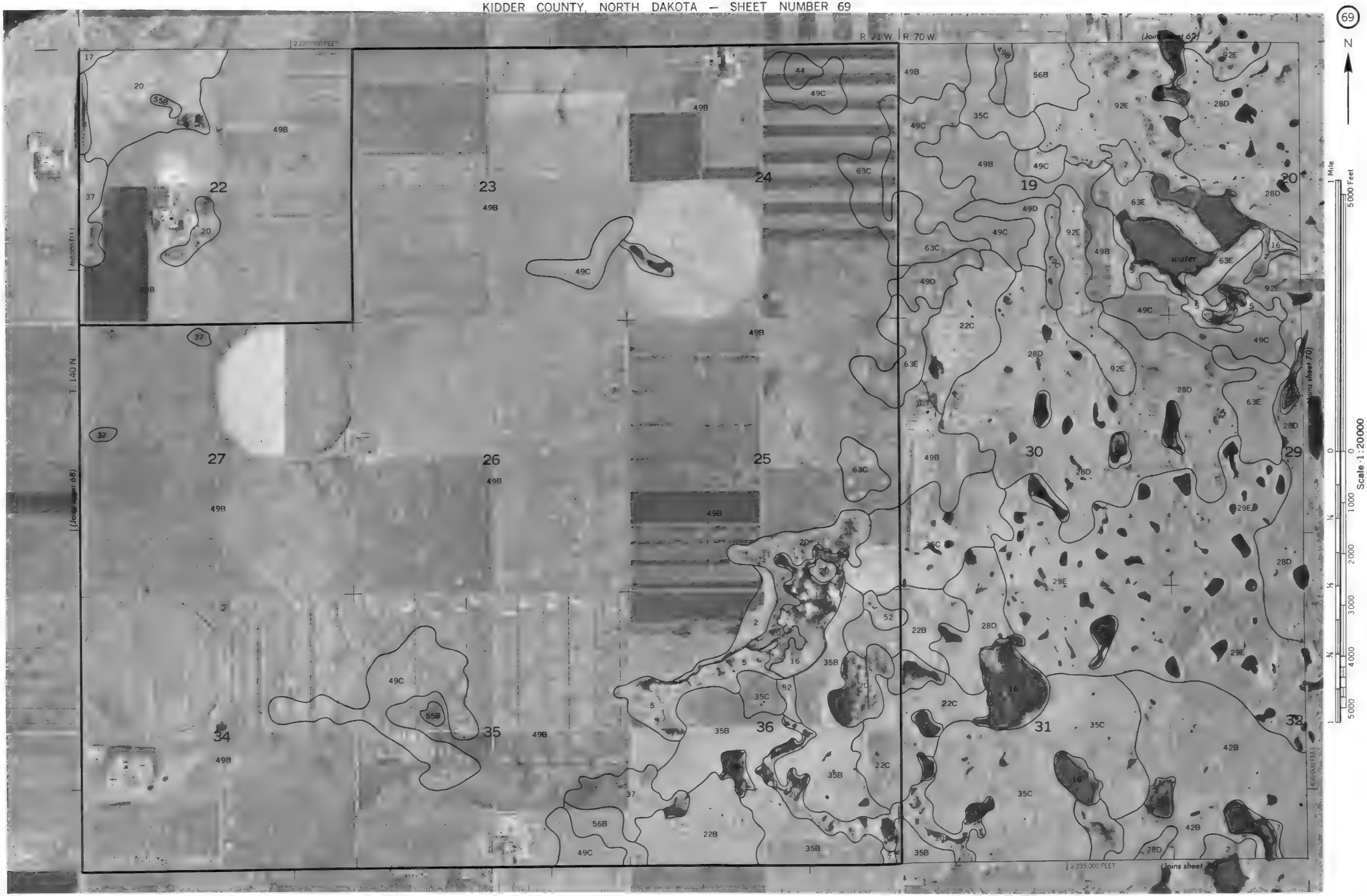
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned

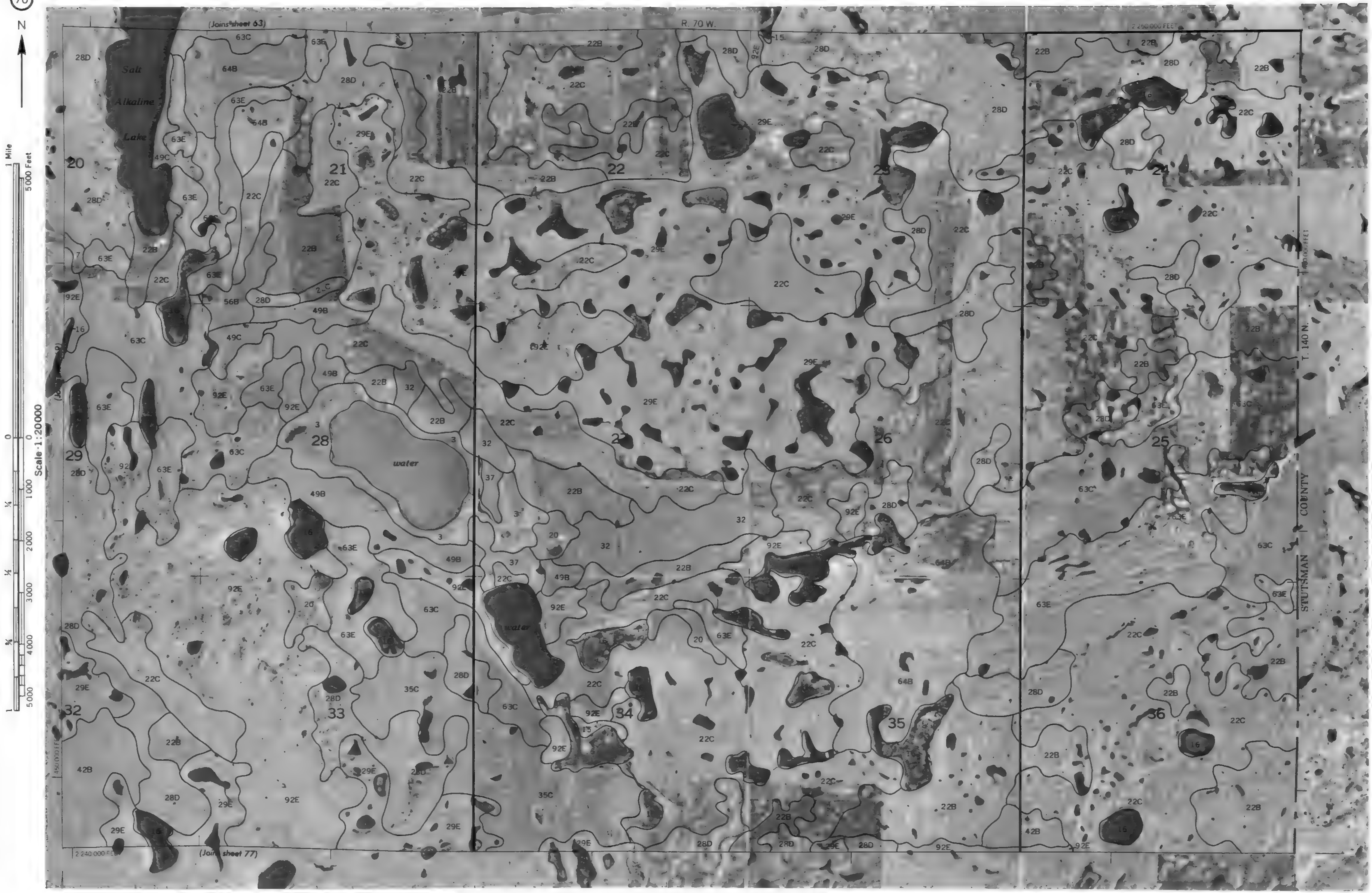
KIDDER COUNTY, NORTH DAKOTA NO. 68

KIDDER COUNTY, NORTH DAKOTA — SHEET NUMBER 69



KIDDER COUNTY, NORTH DAKOTA NO. 69

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned

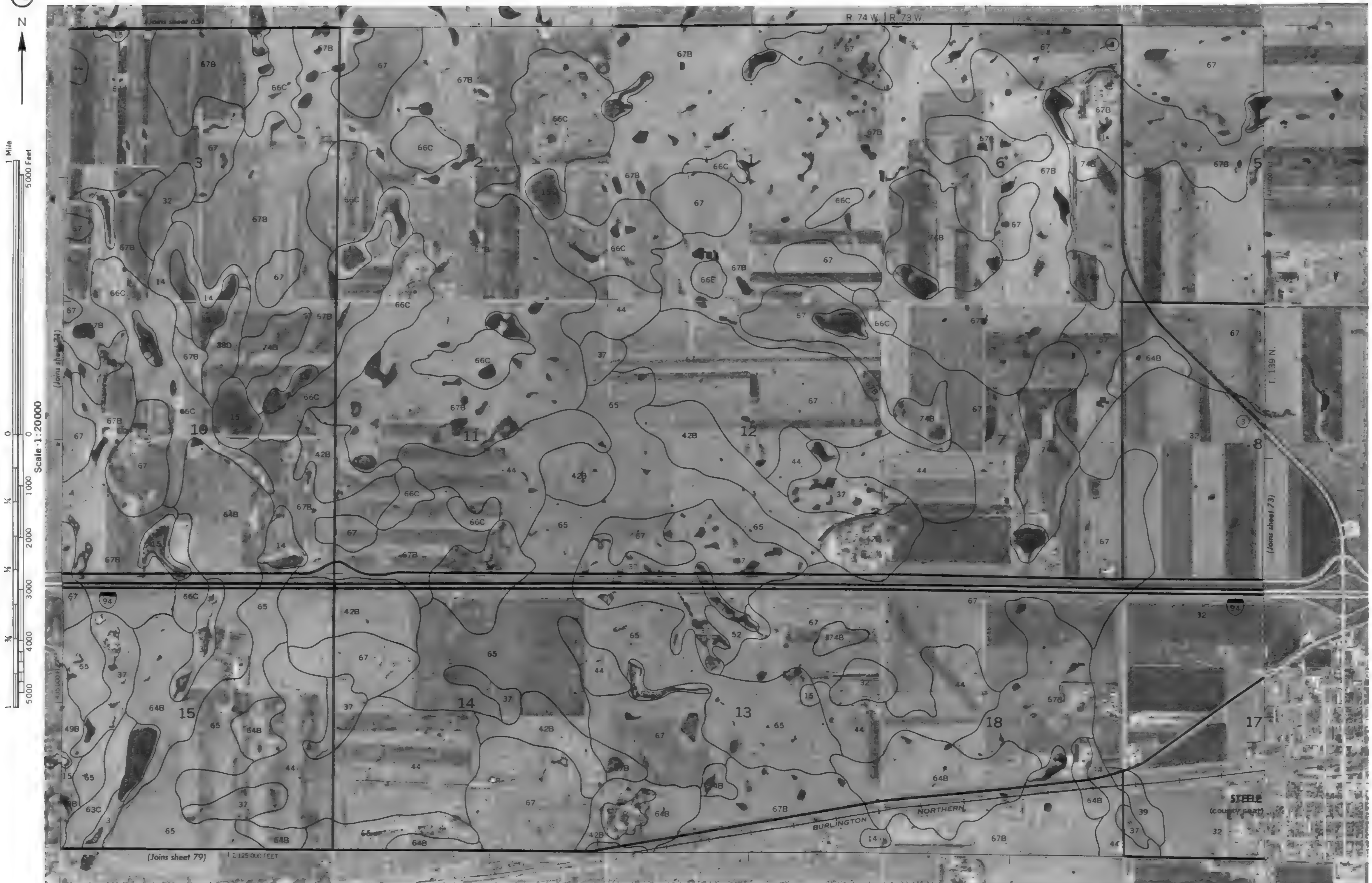


This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

KIDDER COUNTY, NORTH DAKOTA NO. 71

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

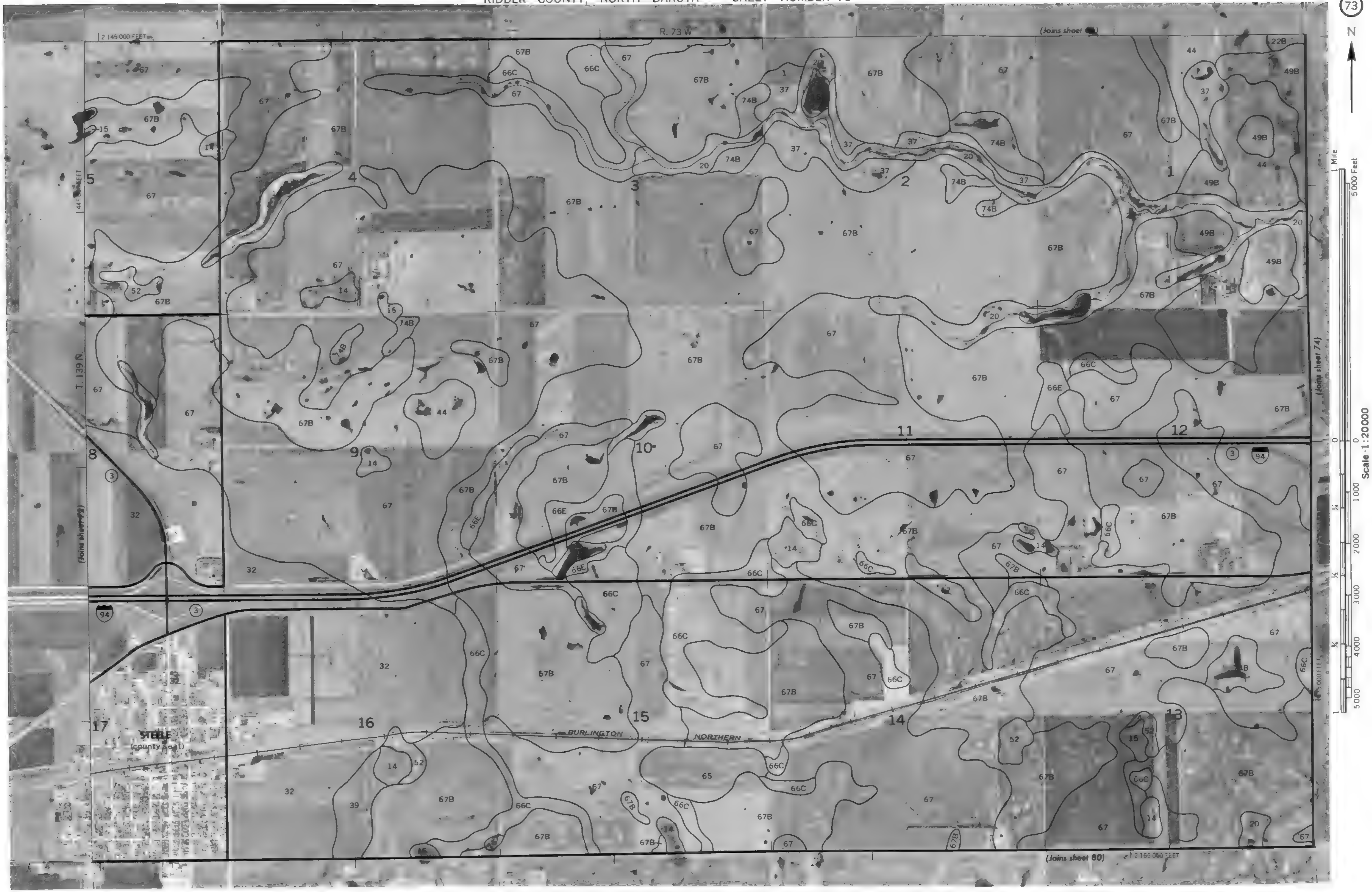
KIDDER COUNTY, NORTH DAKOTA — SHEET NUMBER 72



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

KIDDER COUNTY, NORTH DAKOTA NO. 72

KIDDER COUNTY, NORTH DAKOTA — SHEET NUMBER 73



KIDDER COUNTY, NORTH DAKOTA NO. 73

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

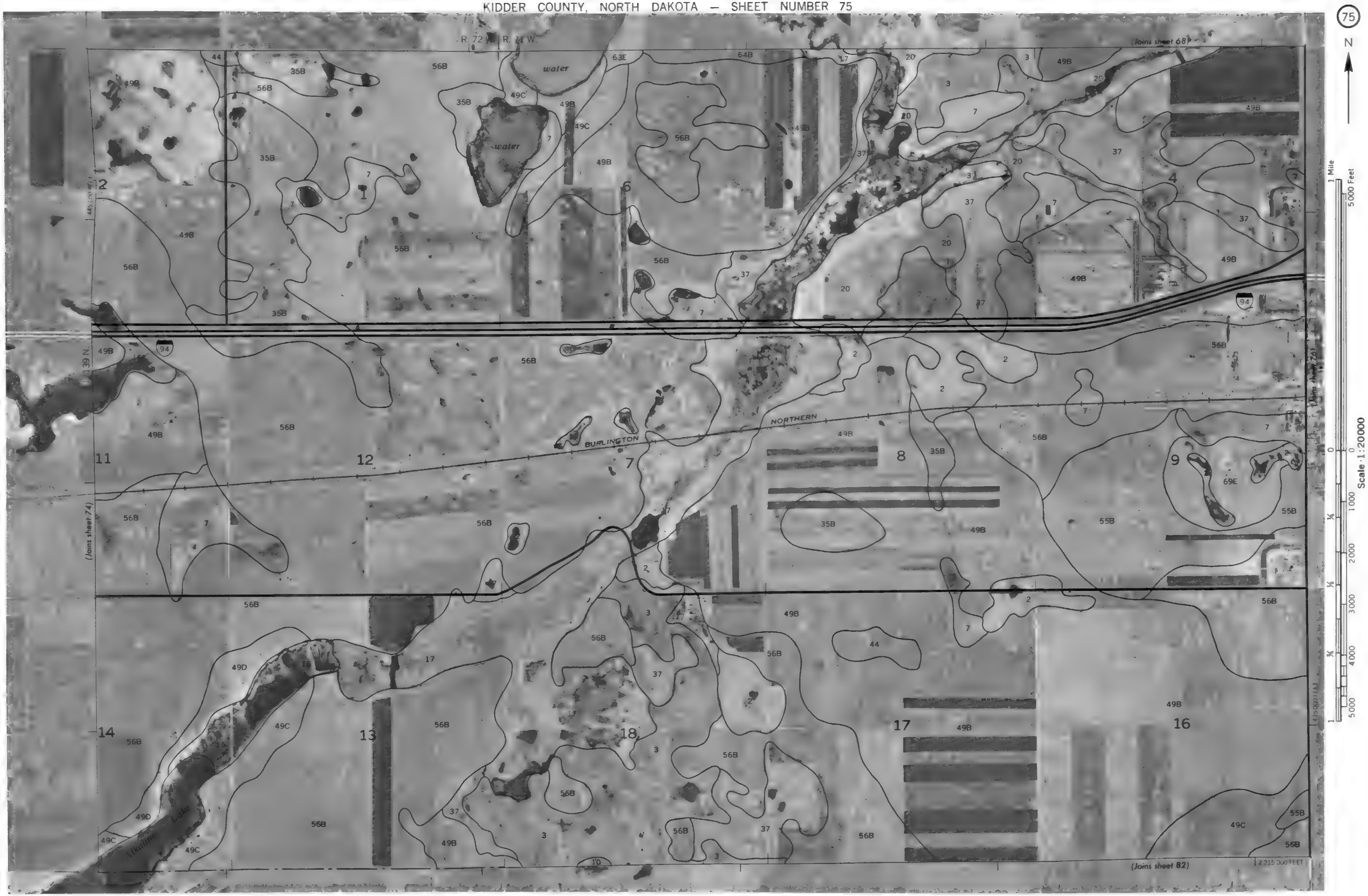
KIDDER COUNTY, NORTH DAKOTA — SHEET NUMBER 74

N

1 Mile
5000 Feet
Scale 1:20000
0 1000 2000 3000 4000 5000

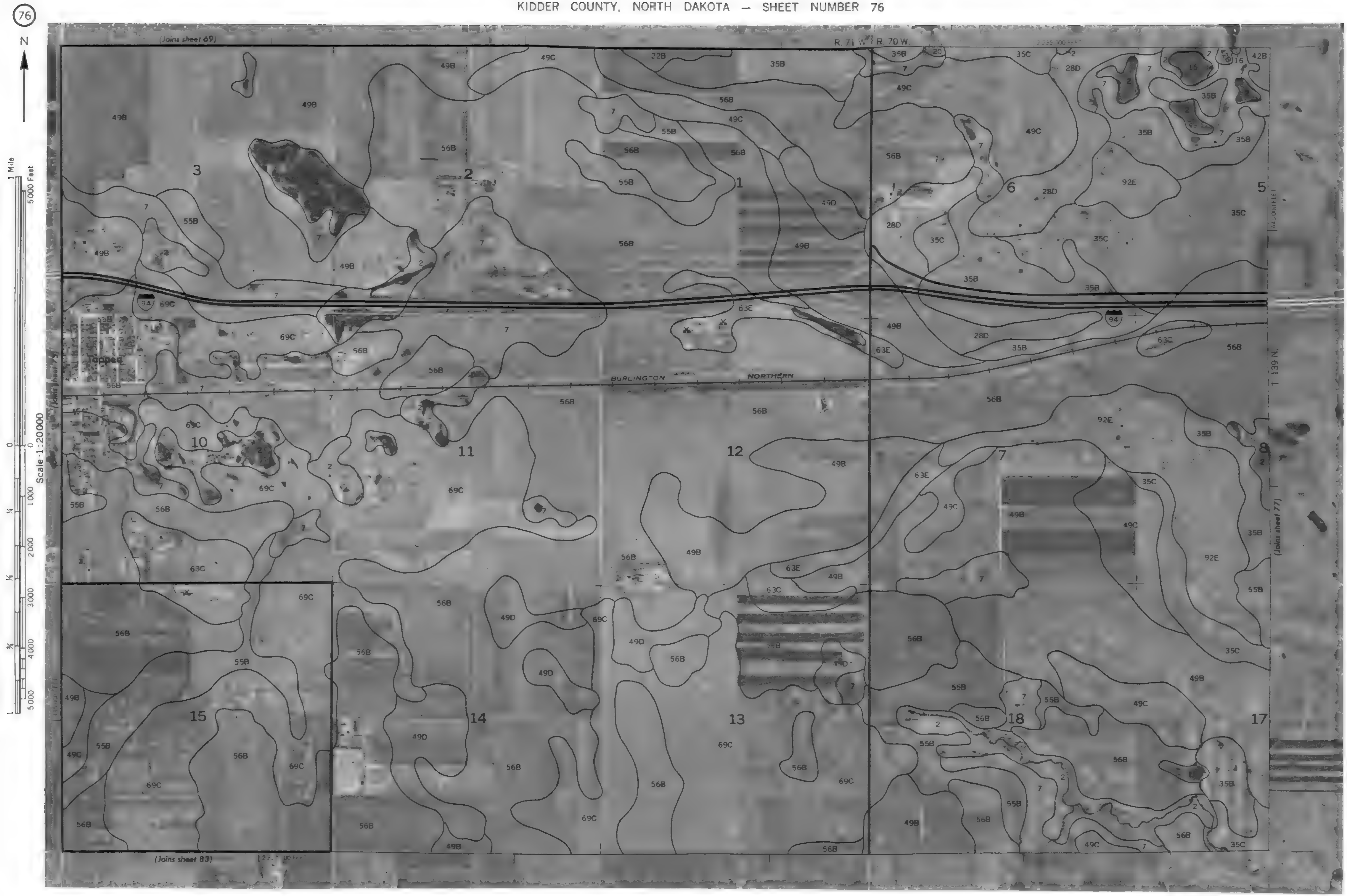
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

KIDDER COUNTY, NORTH DAKOTA NO. 74



KIDDER COUNTY, NORTH DAKOTA NO. 75

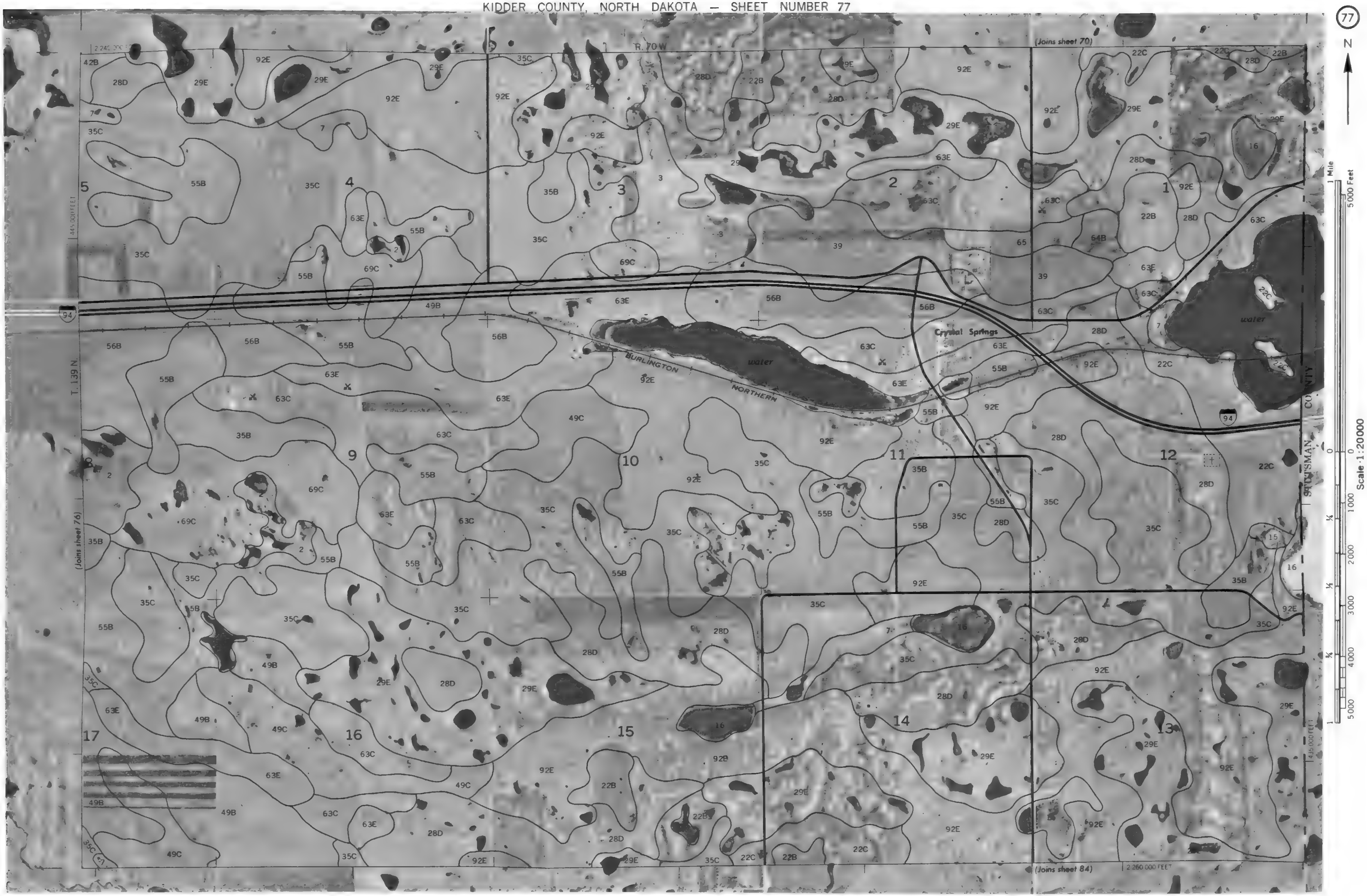
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

KIDDER COUNTY, NORTH DAKOTA NO. 76

KIDDER COUNTY, NORTH DAKOTA — SHEET NUMBER 77

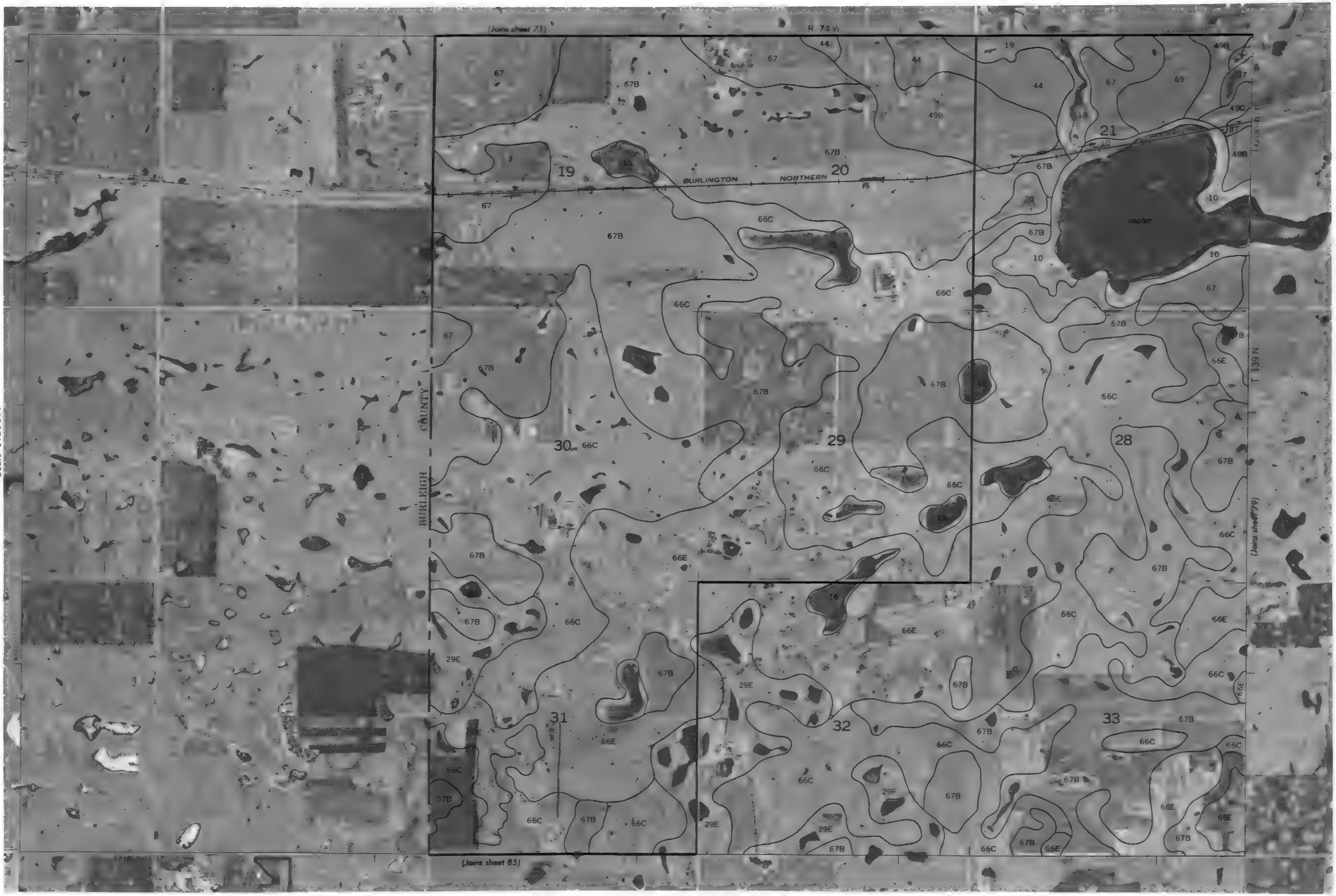


KIDDER COUNTY, NORTH DAKOTA NO. 77

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

N

1 Mile
5000 Feet
Scale 1:20000
0 1000 2000 3000 4000 5000
0 ¼ ½ ¾ 1

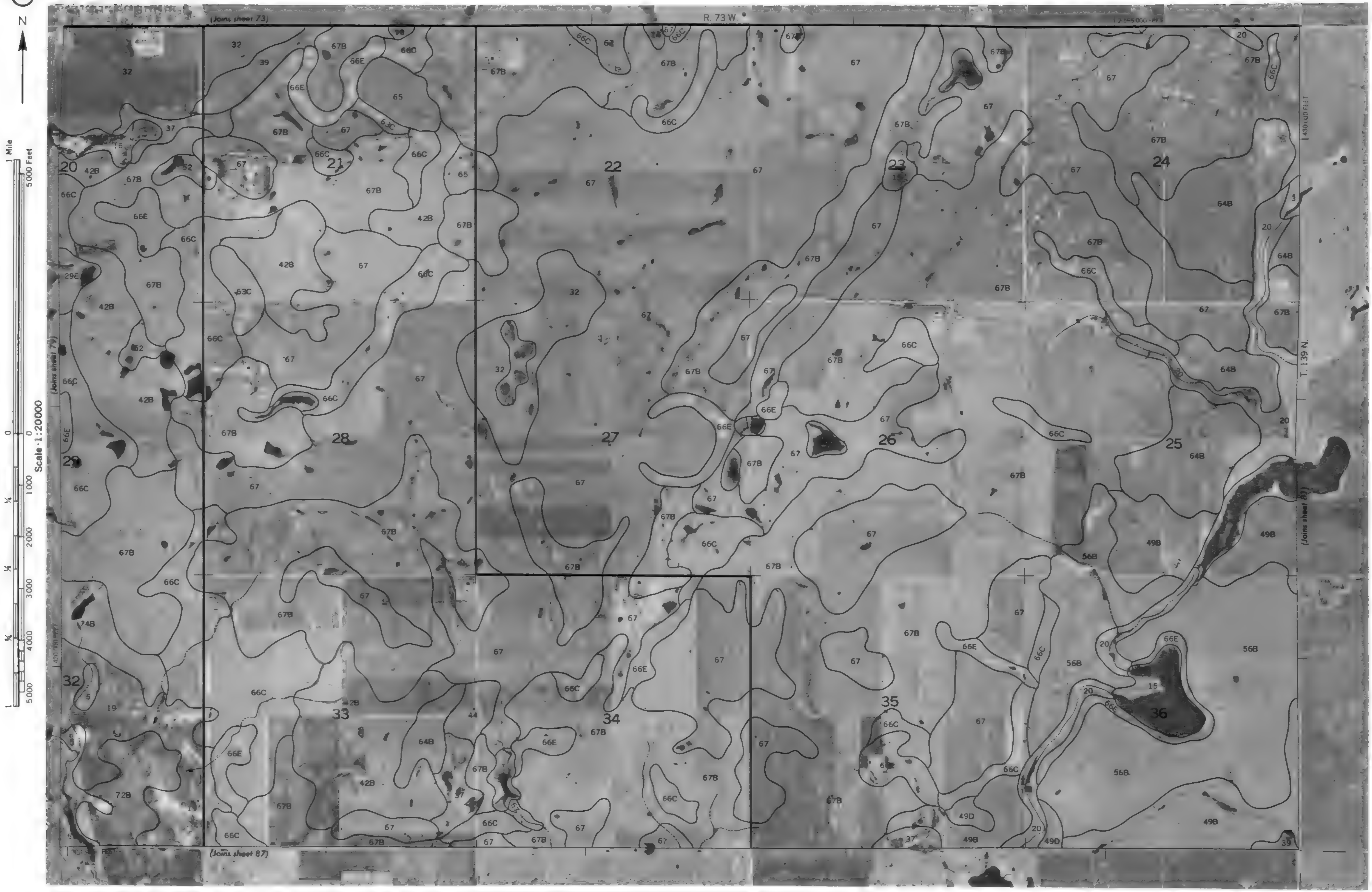


This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

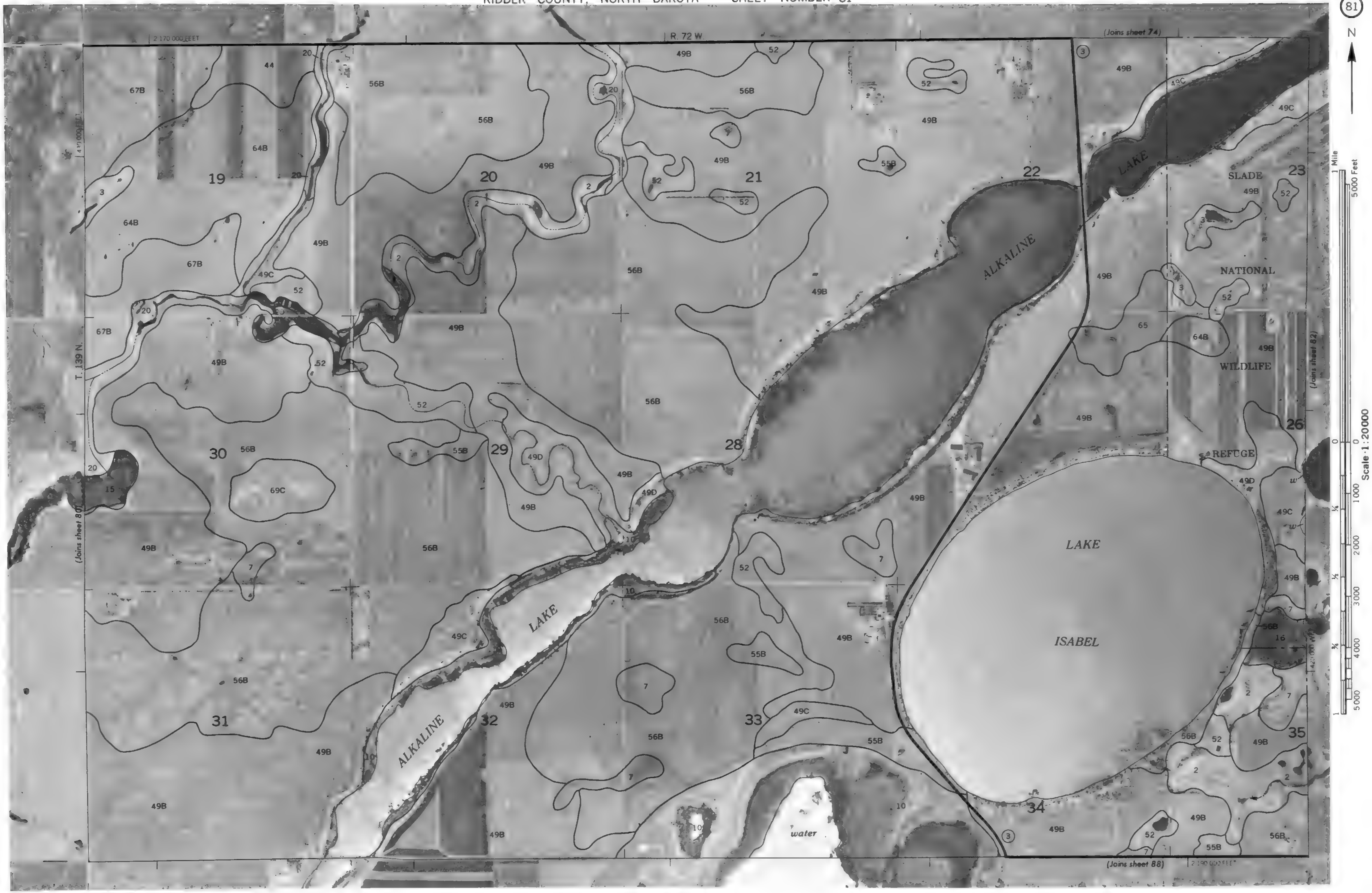
KIDDER COUNTY, NORTH DAKOTA NO. 78

KIDDER COUNTY, NORTH DAKOTA NO. 79

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



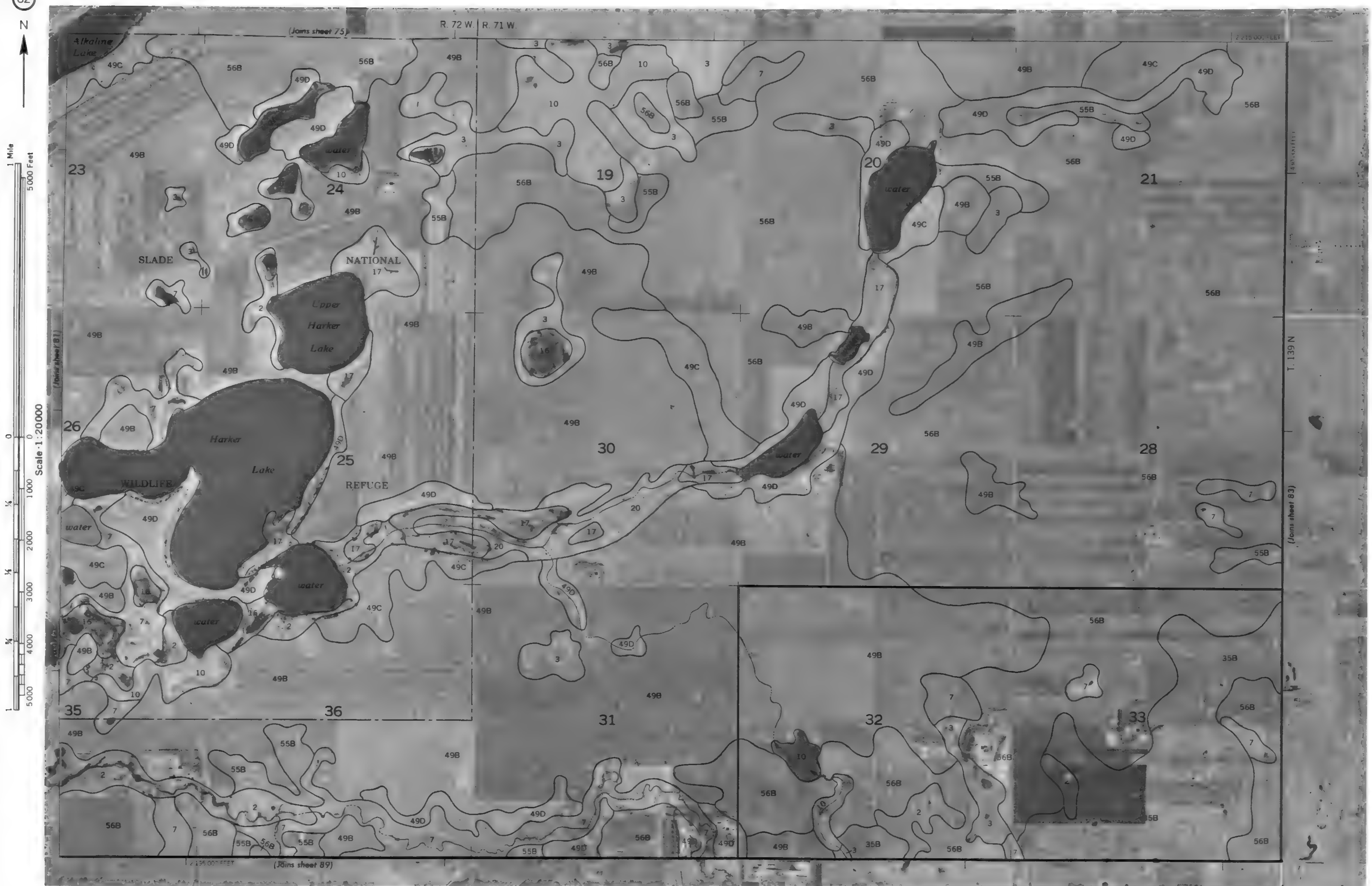
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



KIDDER COUNTY, NORTH DAKOTA NO. 81

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

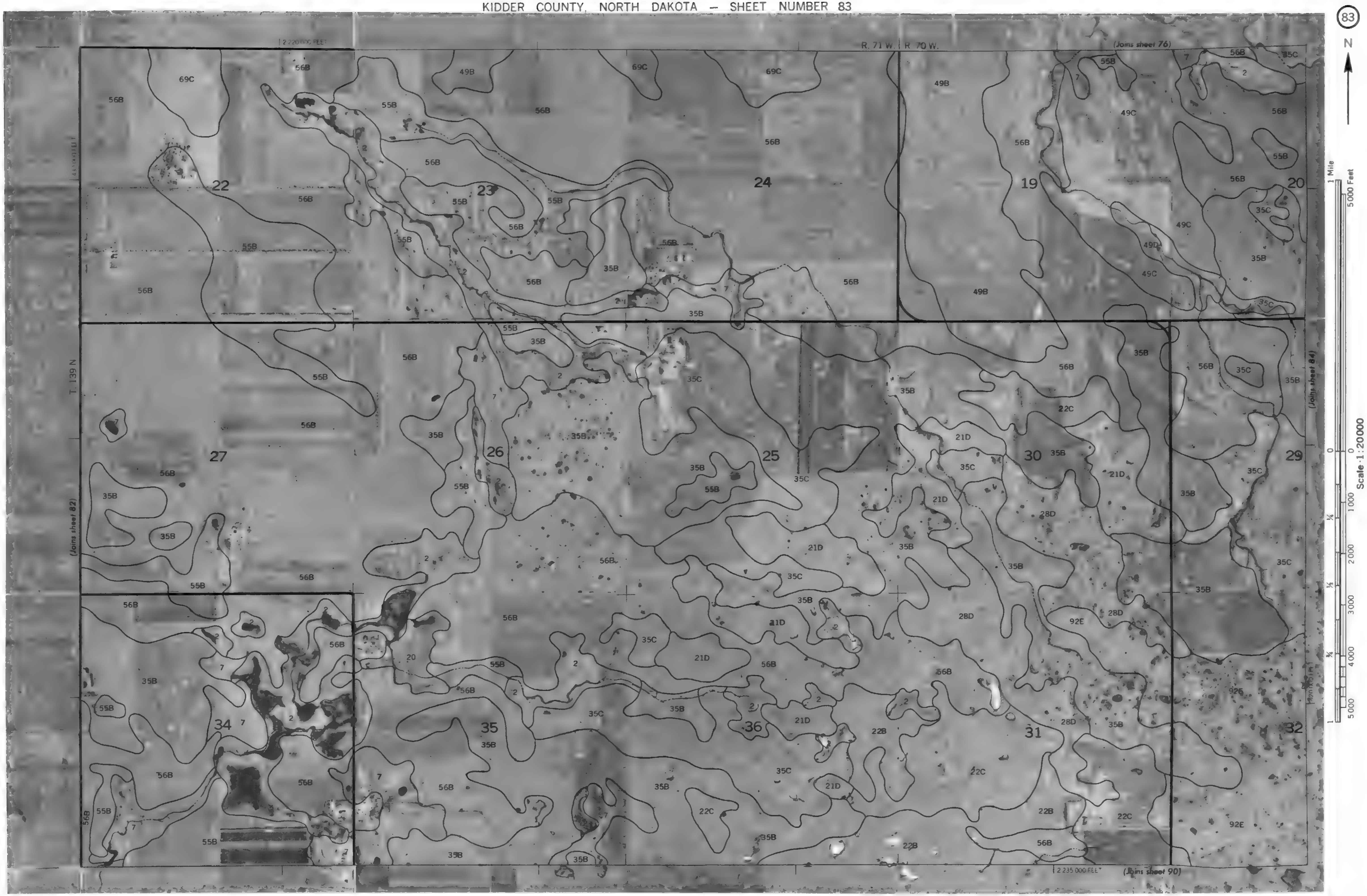
KIDDER COUNTY, NORTH DAKOTA — SHEET NUMBER 82



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

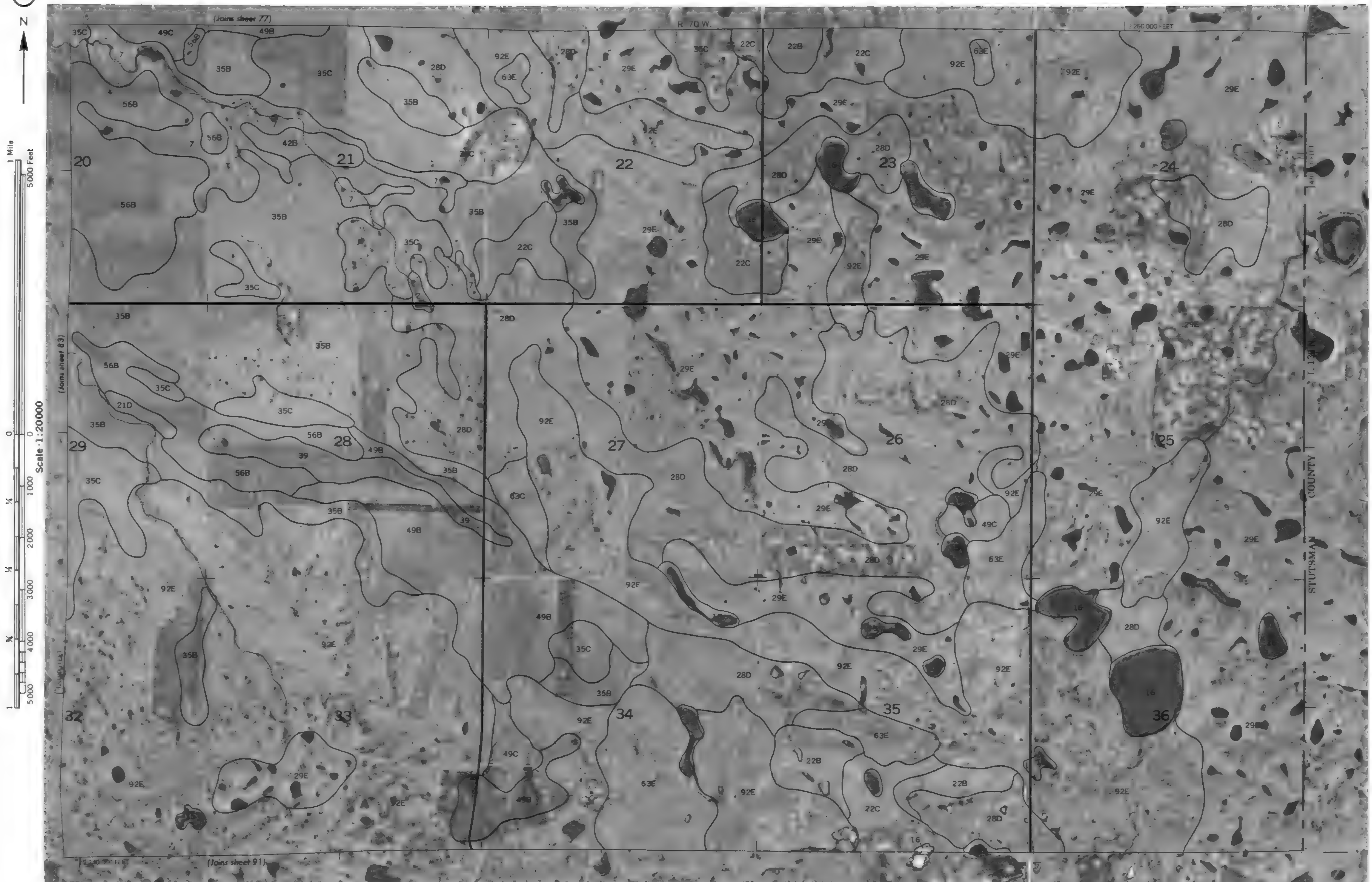
KIDDER COUNTY, NORTH DAKOTA NO. 82

KIDDER COUNTY, NORTH DAKOTA — SHEET NUMBER 83



KIDDER COUNTY, NORTH DAKOTA NO. 83

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



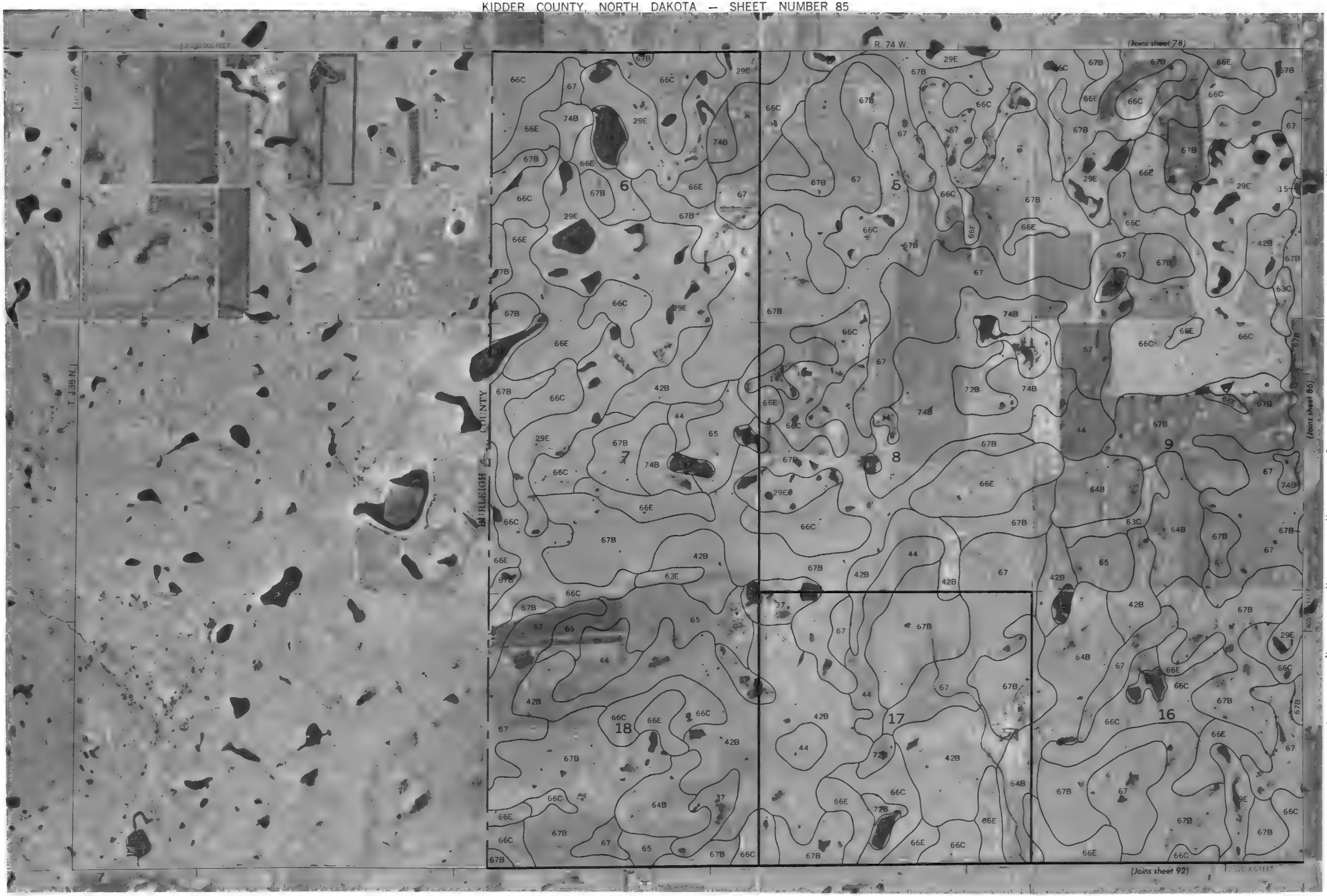
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned

KIDDER COUNTY, NORTH DAKOTA NO. 84

85

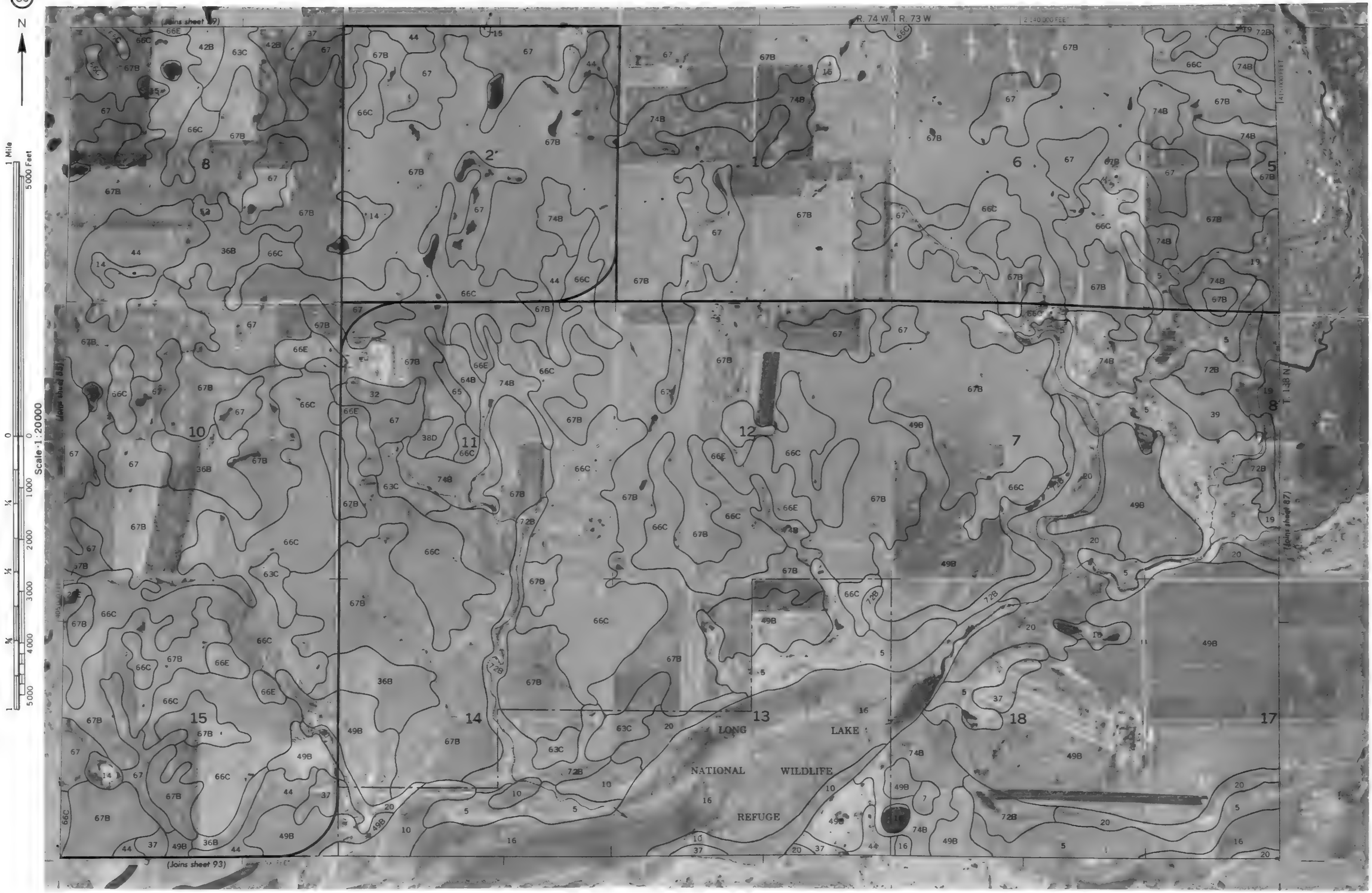
KIDDER COUNTY, NORTH DAKOTA NO. 85

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



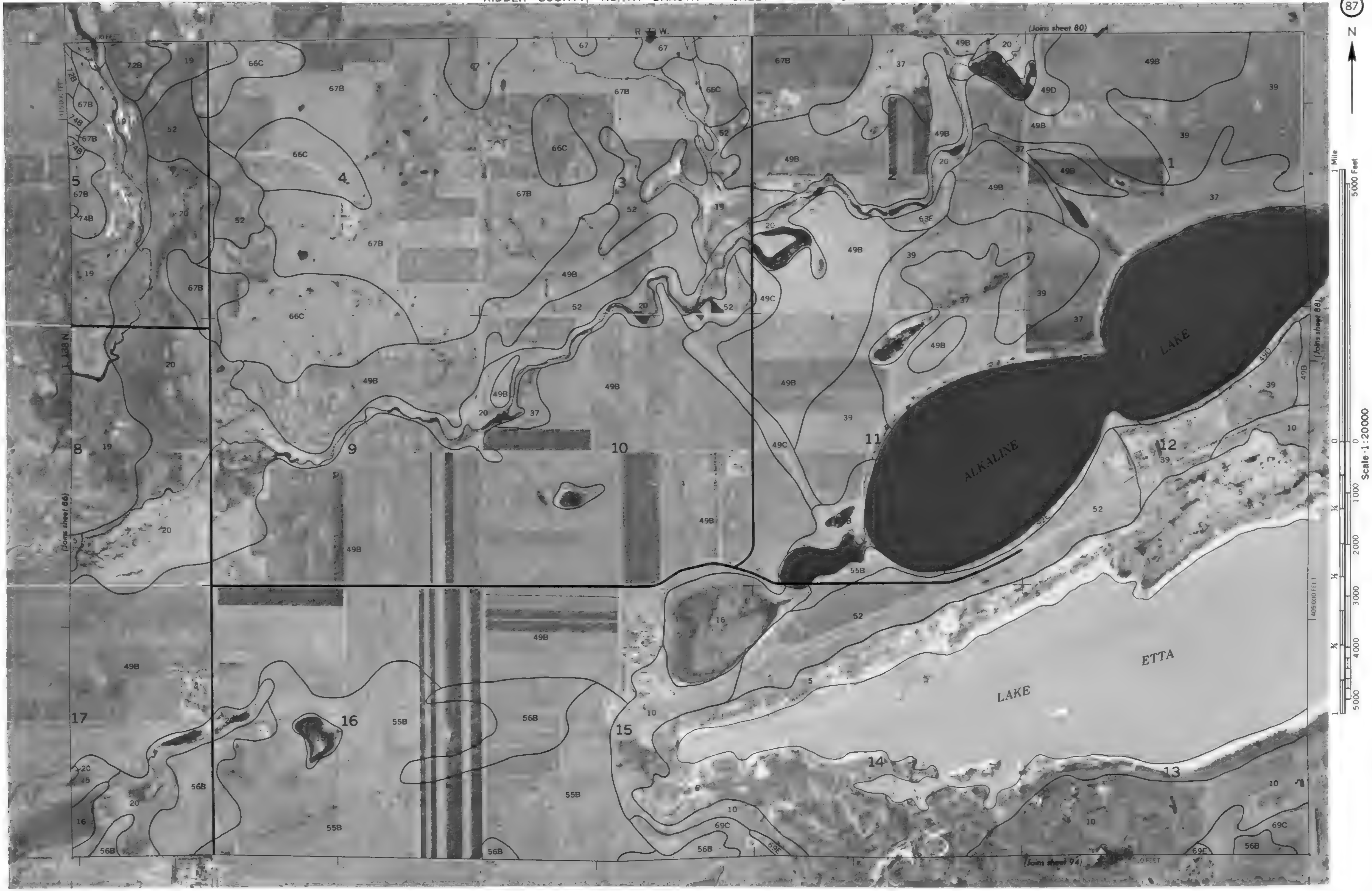
N

1 Mile
5000 Feet
Scale 1:20000
0 1000 2000 3000 4000 5000



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

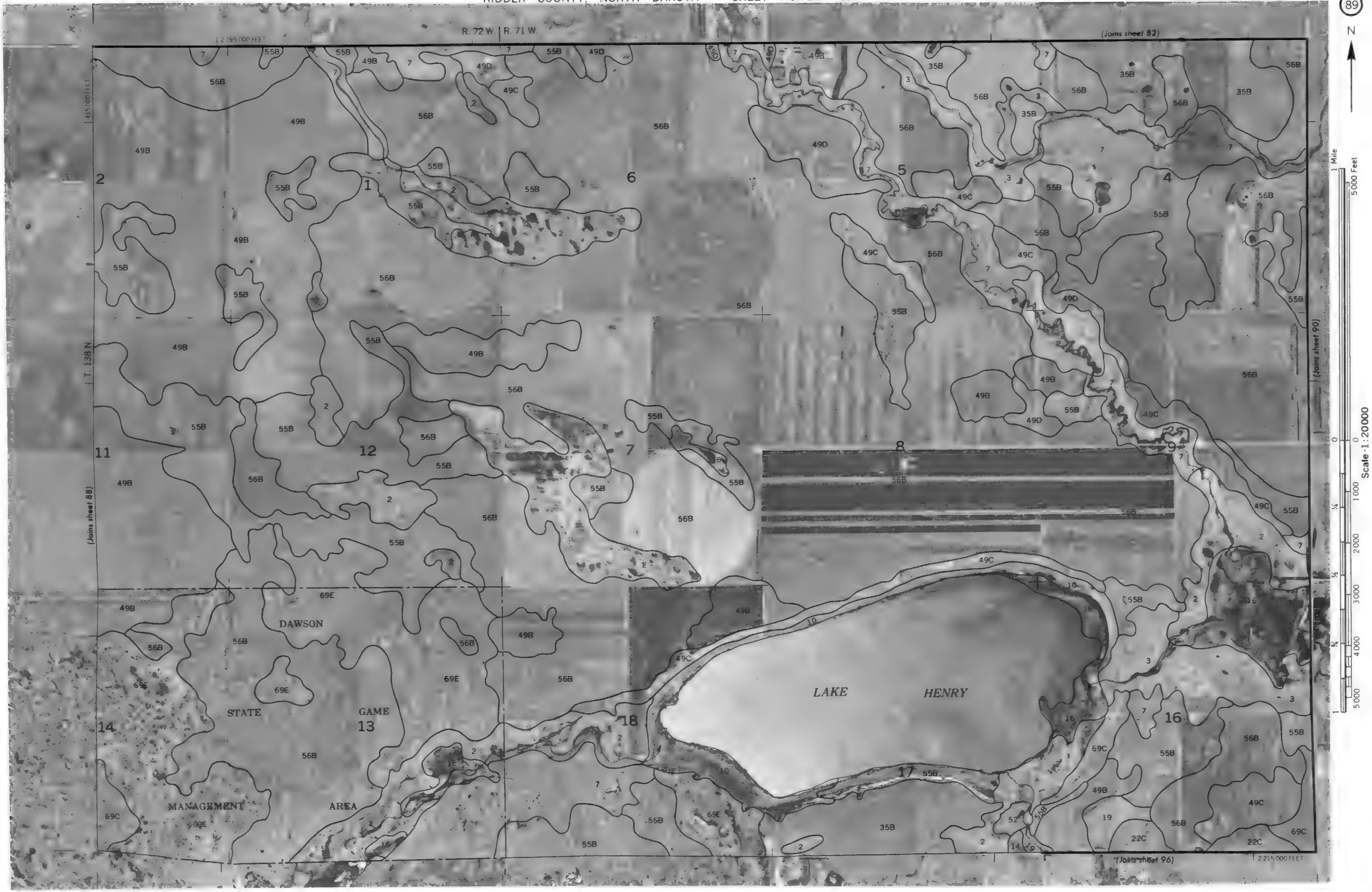
KIDDER COUNTY, NORTH DAKOTA NO. 86



KIDDER COUNTY, NORTH DAKOTA NO. 87

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned



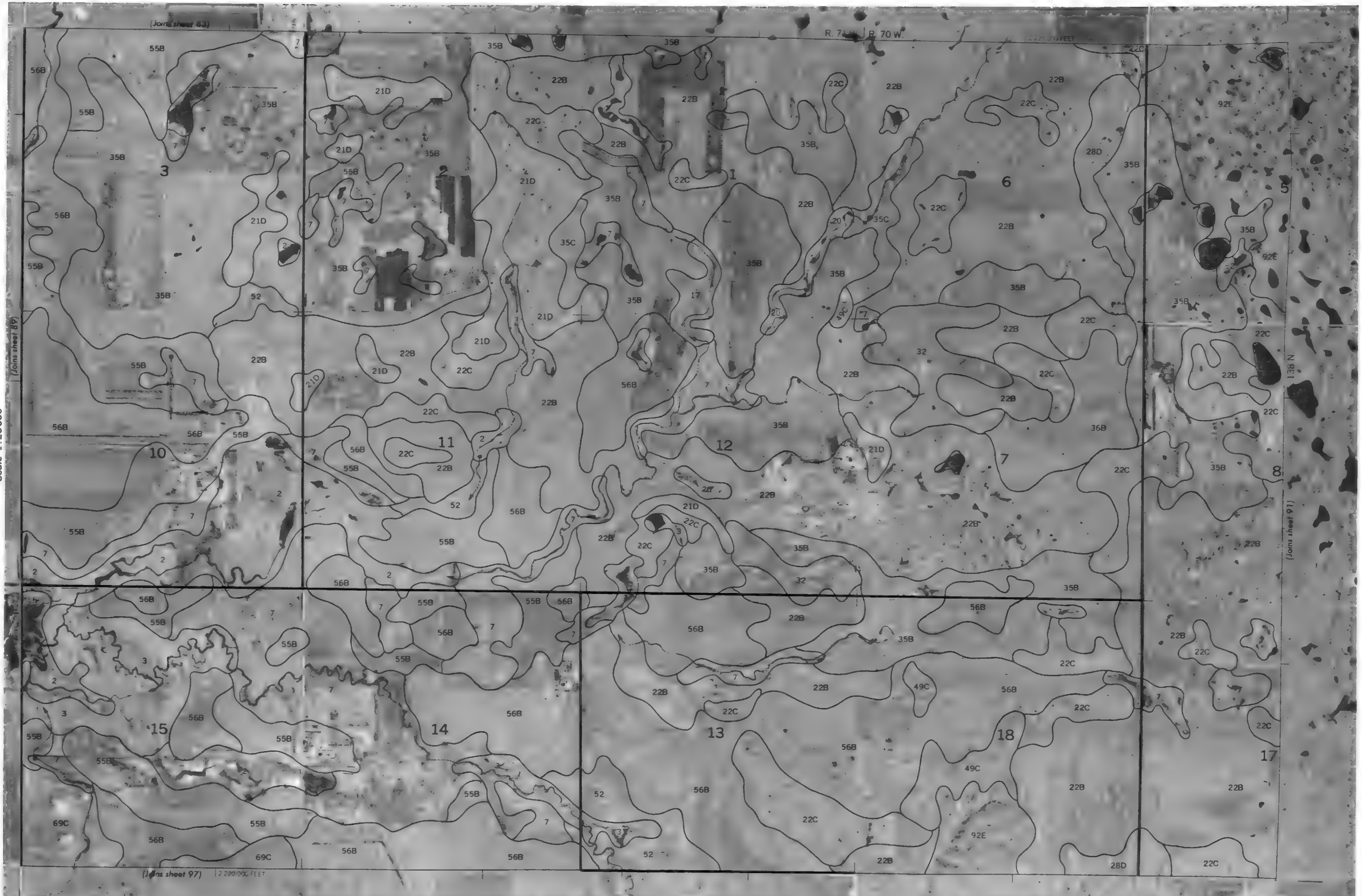
KIDDER COUNTY, NORTH DAKOTA NO. 89

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

KIDDER COUNTY, NORTH DAKOTA — SHEET NUMBER 90

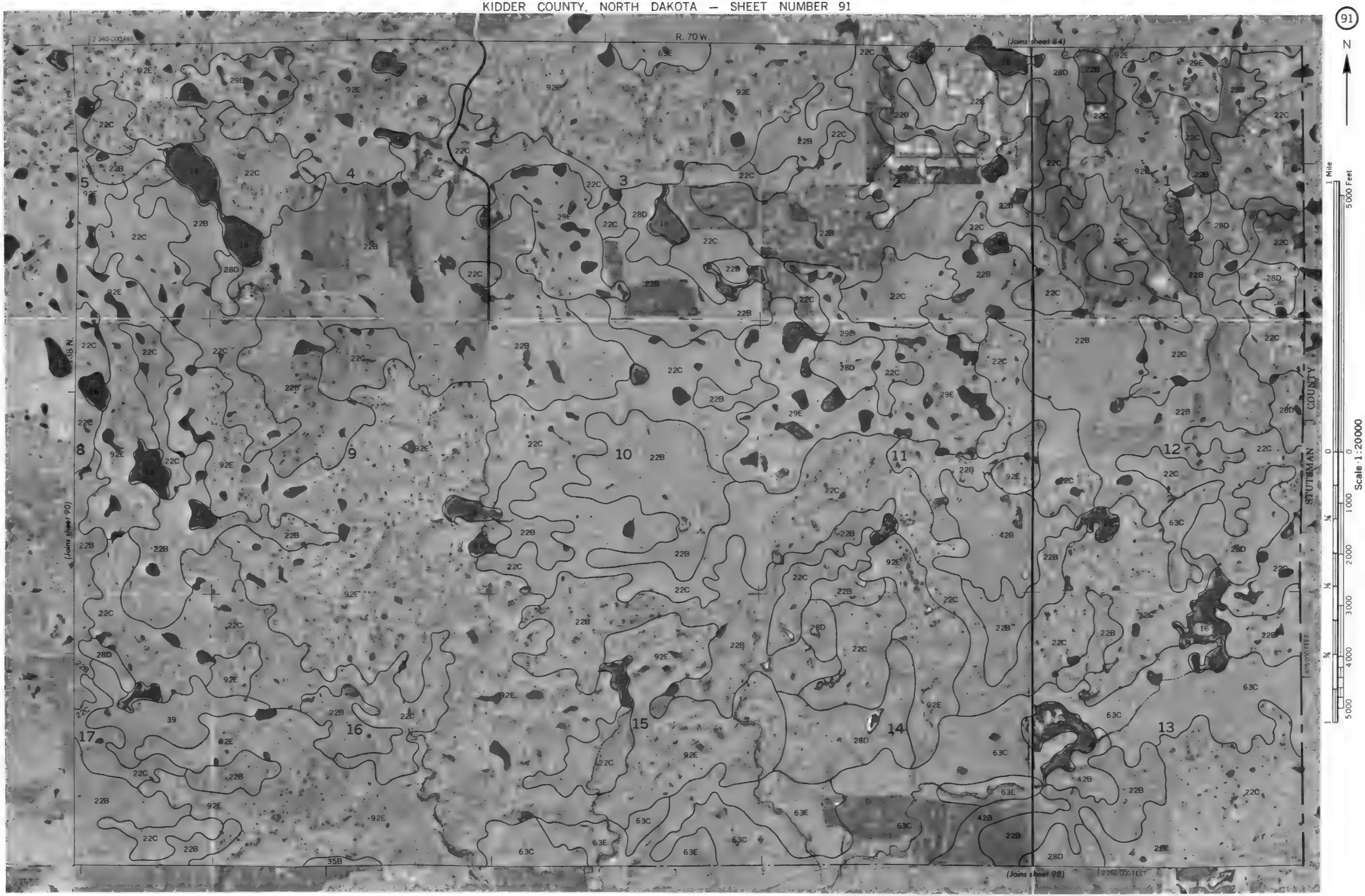
N

1 Mile
5000 Feet
Scale 1:20000
0 1000 2000 3000 4000 5000
0 ¼ ½ ¾ 1



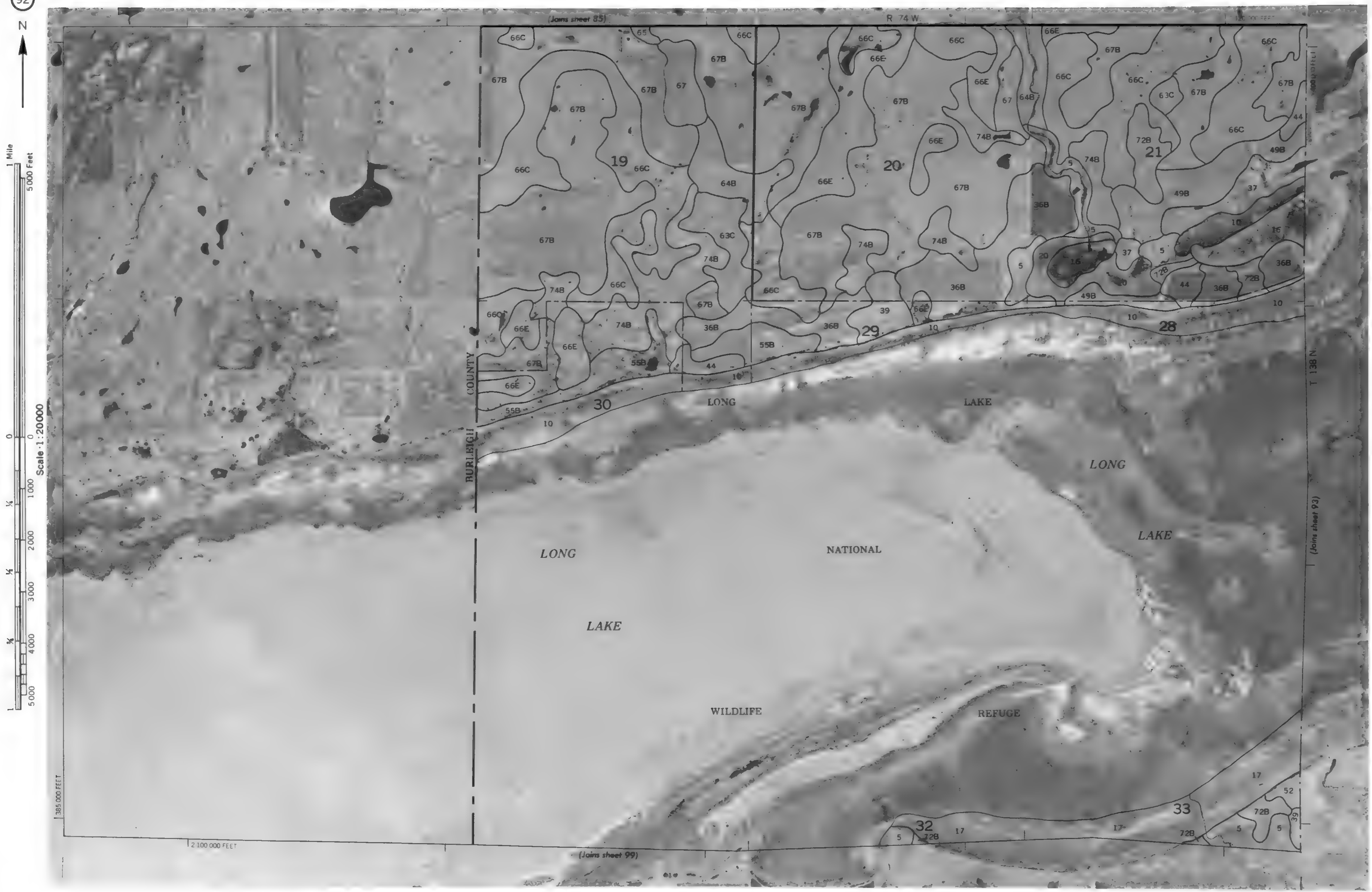
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

KIDDER COUNTY, NORTH DAKOTA NO. 90

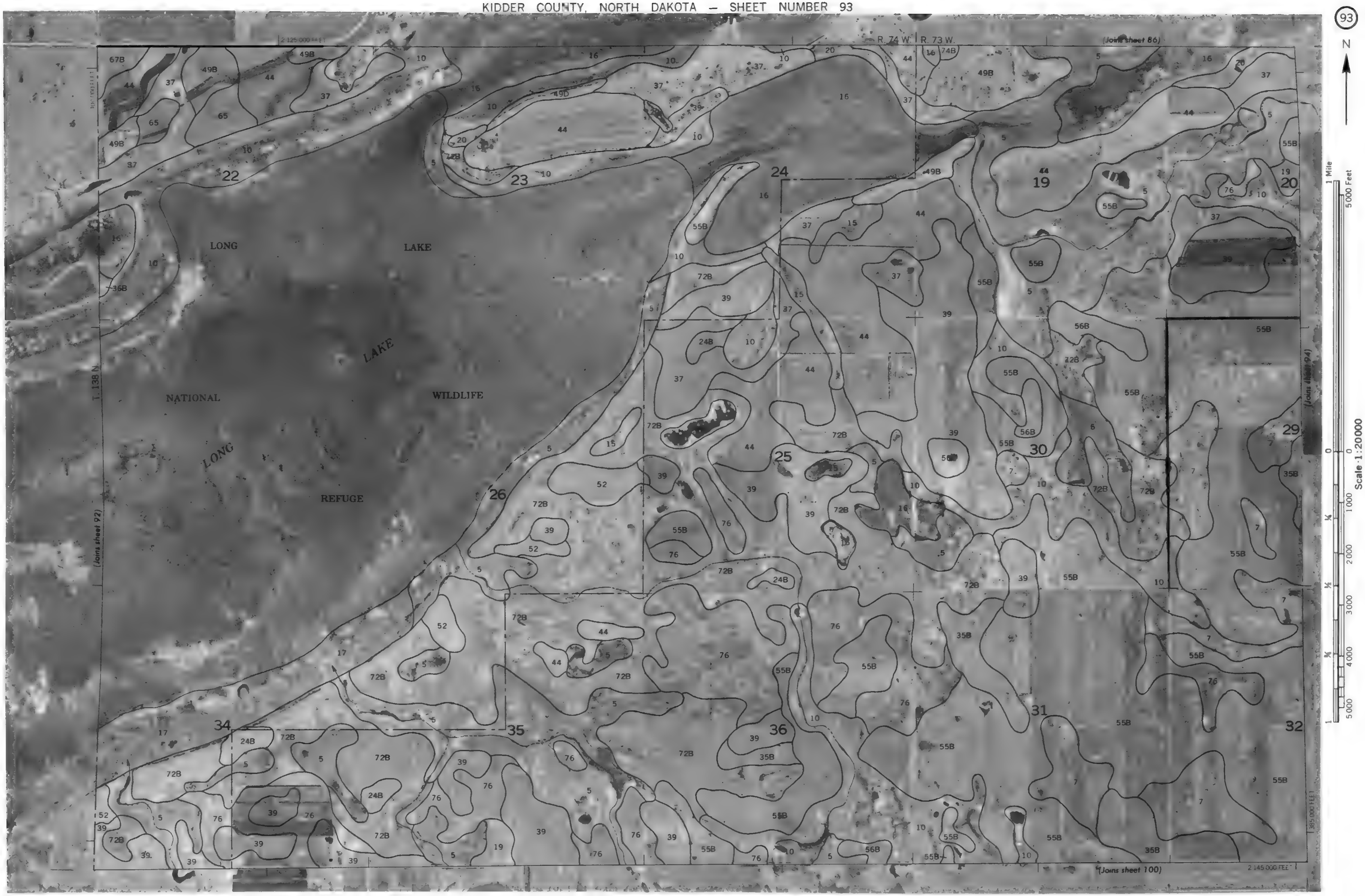


KIDDER COUNTY, NORTH DAKOTA NO. 91

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is [redacted] on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and [redacted] agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



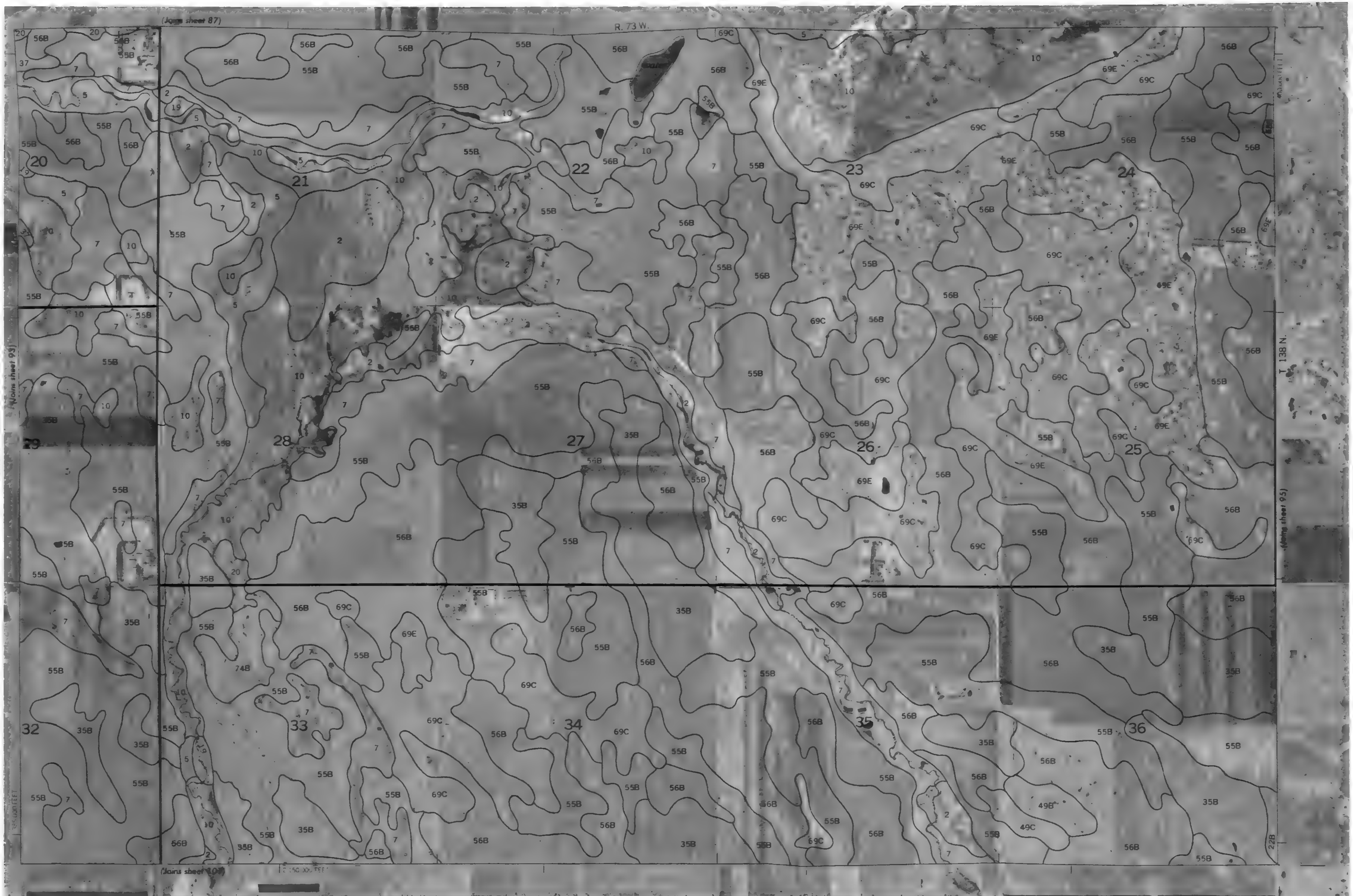
KIDDER COUNTY, NORTH DAKOTA NO. 93

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

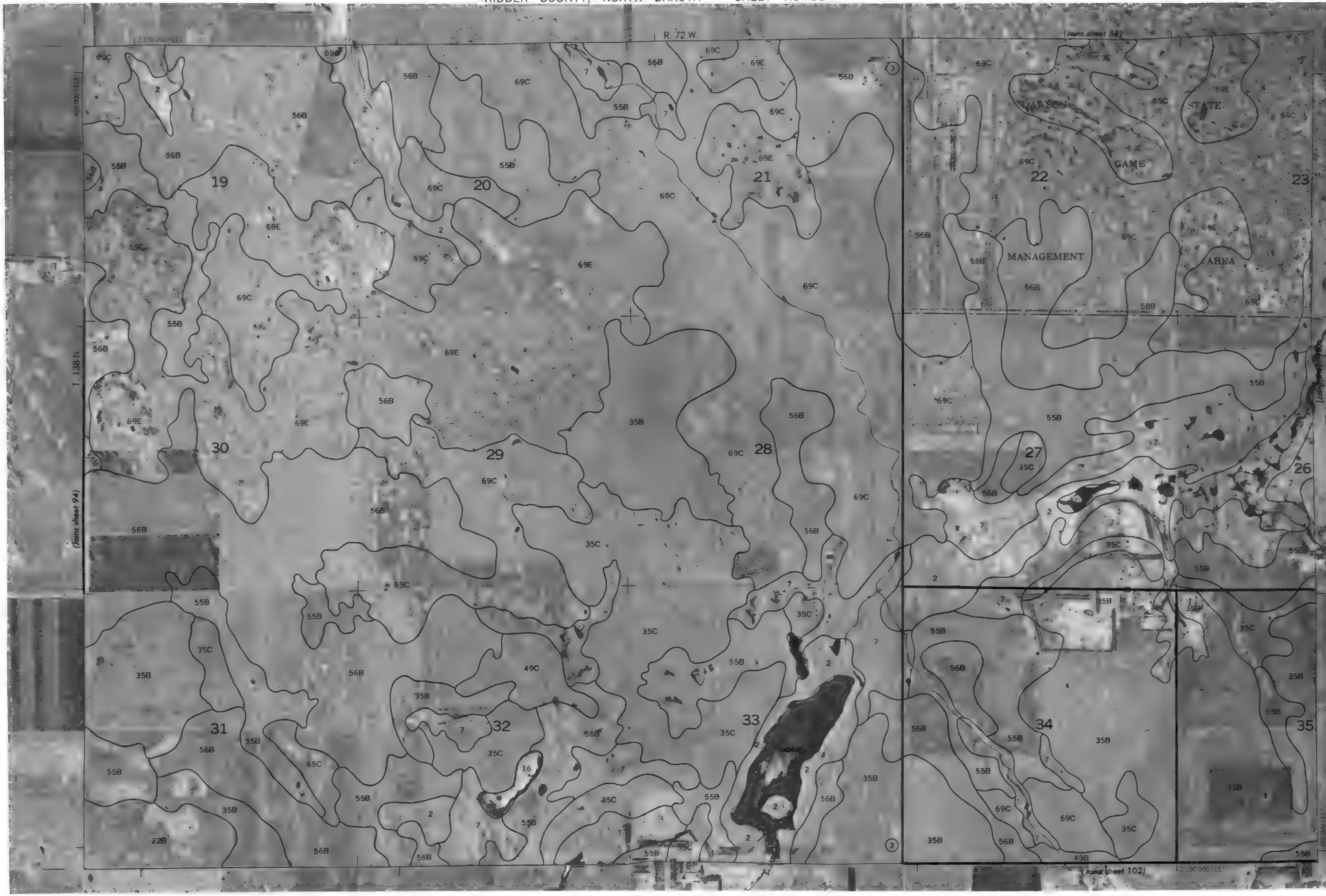
KIDDER COUNTY, NORTH DAKOTA — SHEET NUMBER 94

N

1 Mile
5000 Feet
Scale 1:20000



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



KIDDER COUNTY, NORTH DAKOTA NO. 95

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

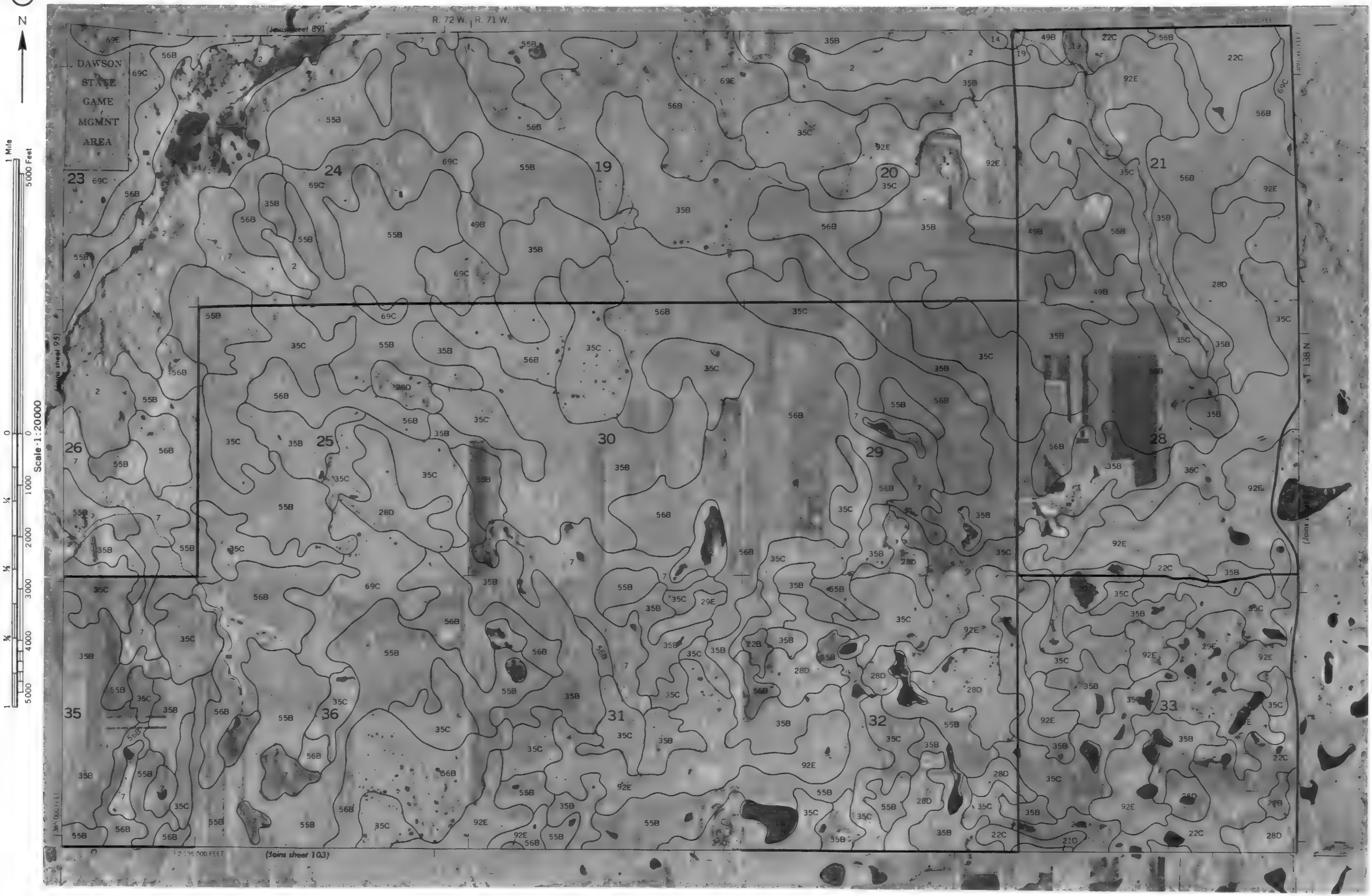
N

1 Mile

5000 Feet

Scale 1:20000

KIDDER COUNTY, NORTH DAKOTA — SHEET NUMBER 96

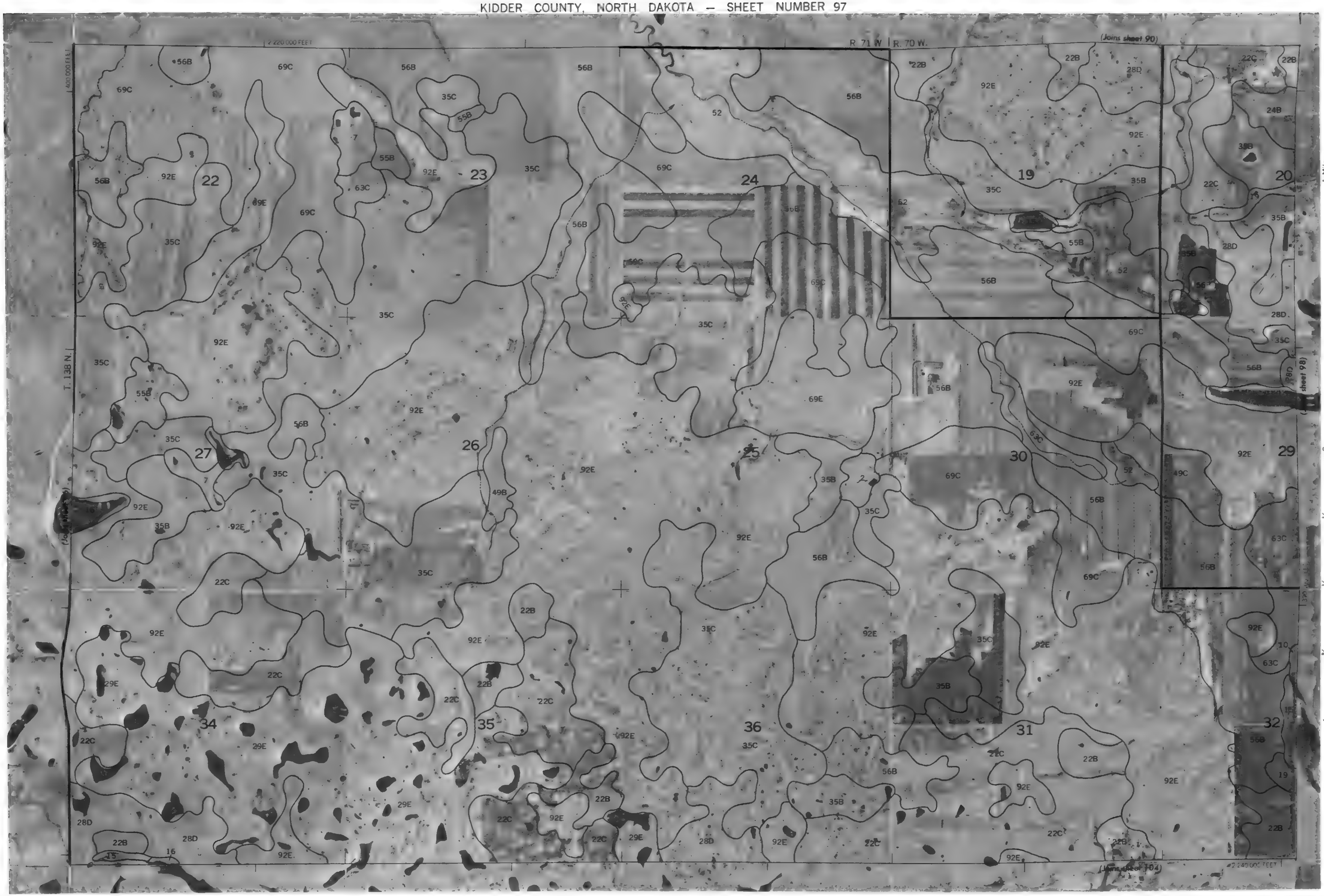


This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

KIDDER COUNTY, NORTH DAKOTA NO. 96

KIDDER COUNTY, NORTH DAKOTA — SHEET NUMBER 97

97

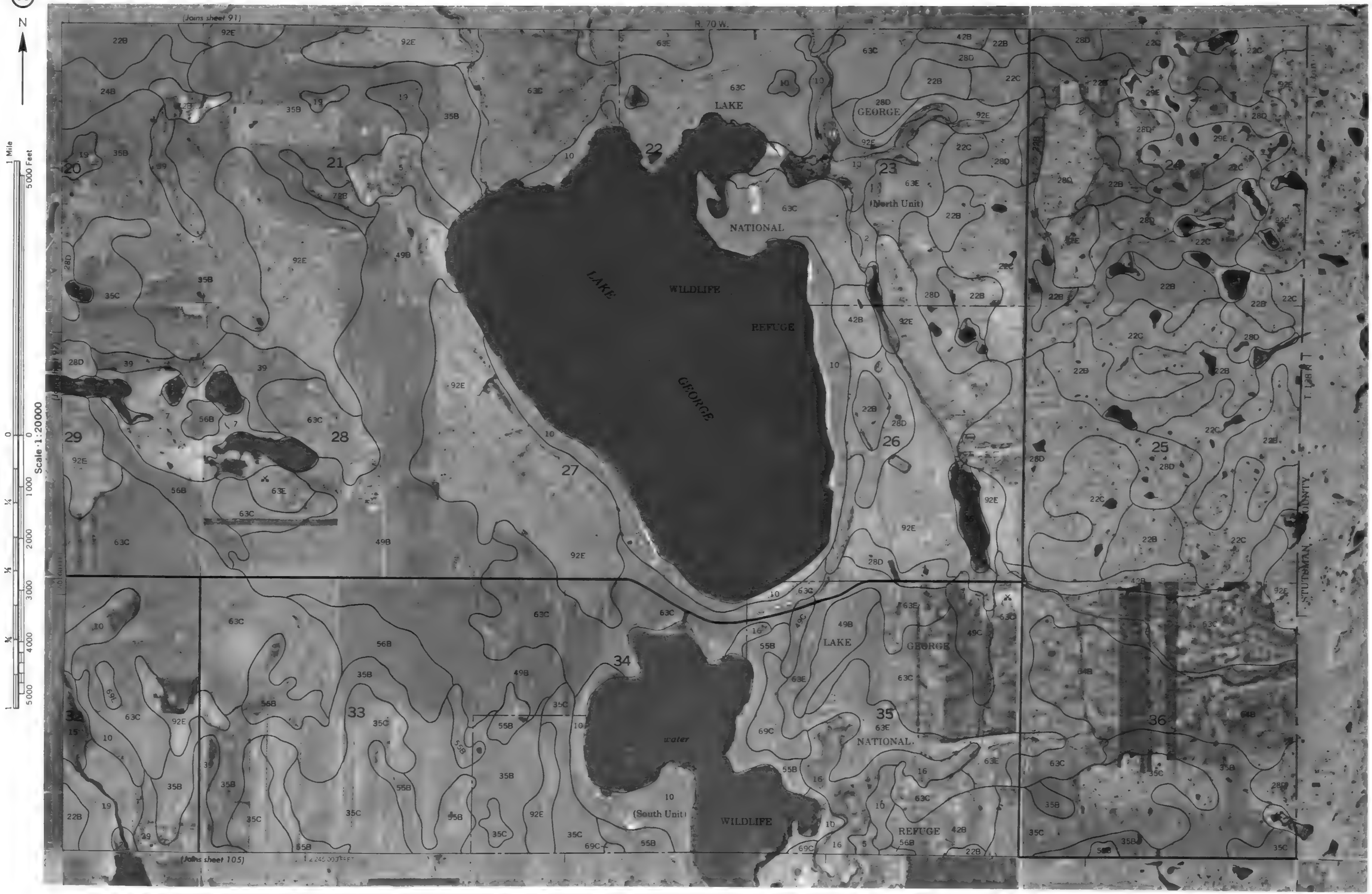


N

1 Mile
5000 Feet
Scale 1:20000

KIDDER COUNTY, NORTH DAKOTA NO. 97

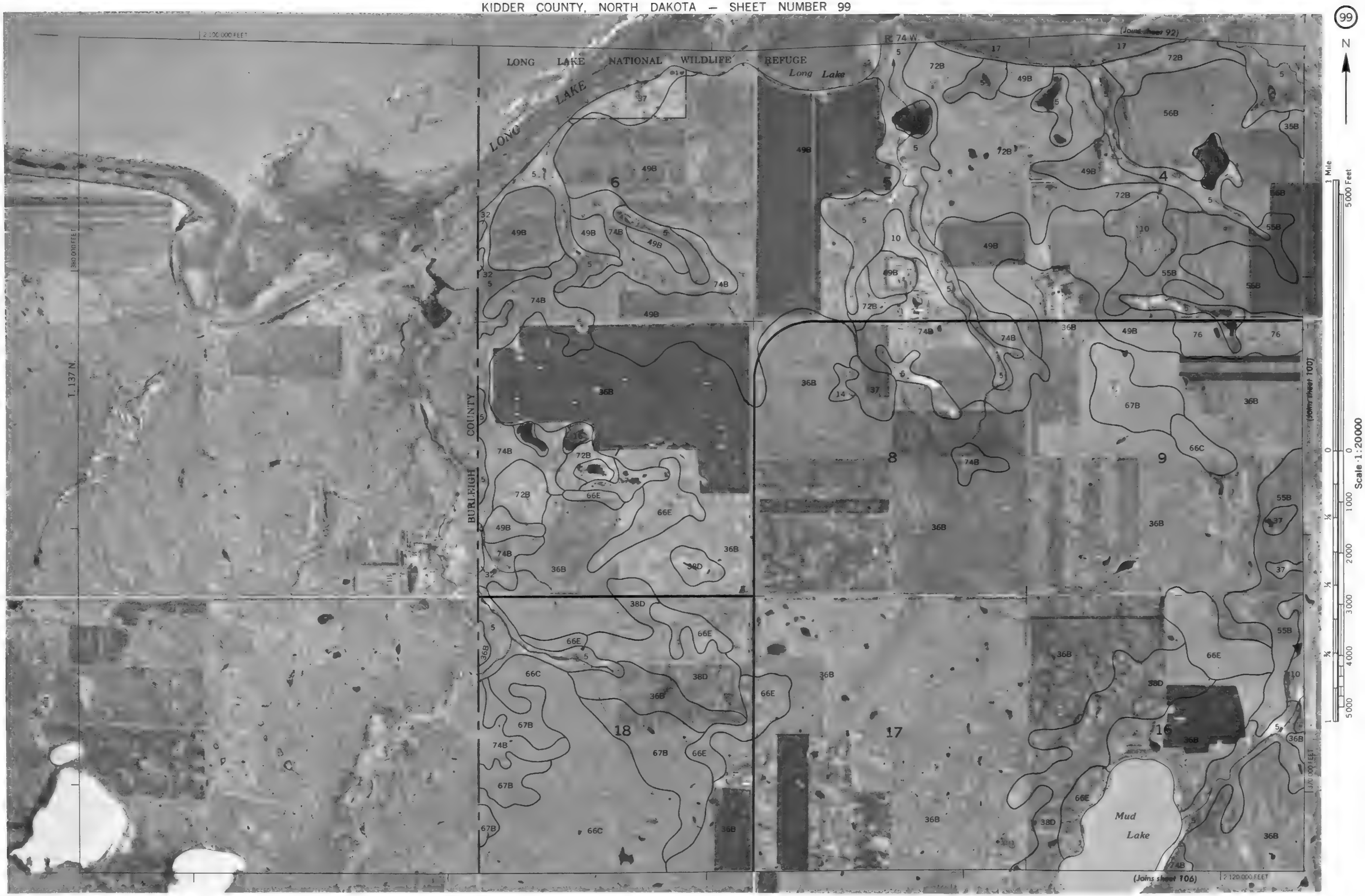
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned

KIDDER COUNTY, NORTH DAKOTA NO. 99

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

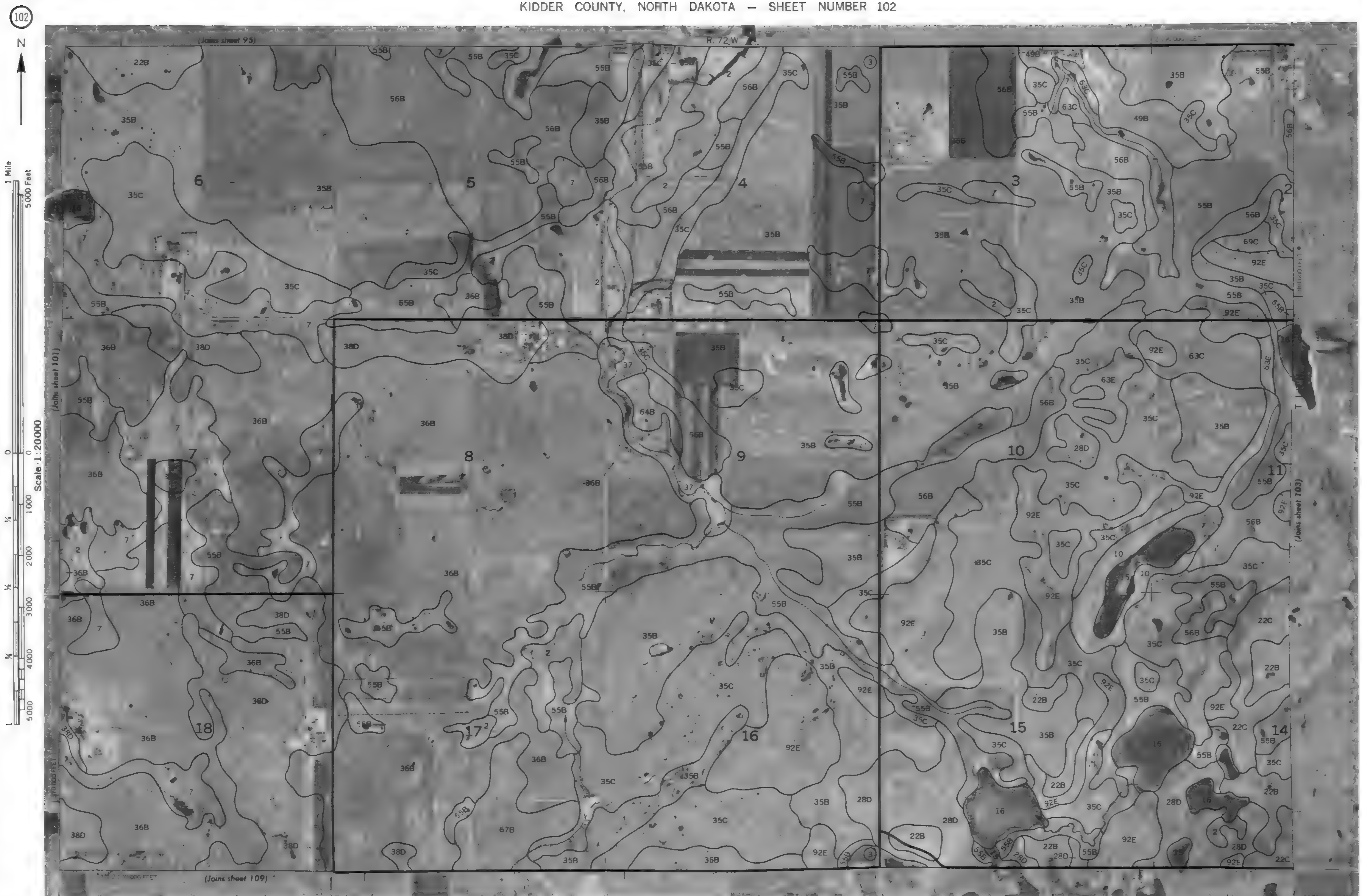


This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

KIDDER COUNTY, NORTH DAKOTA NO. 100

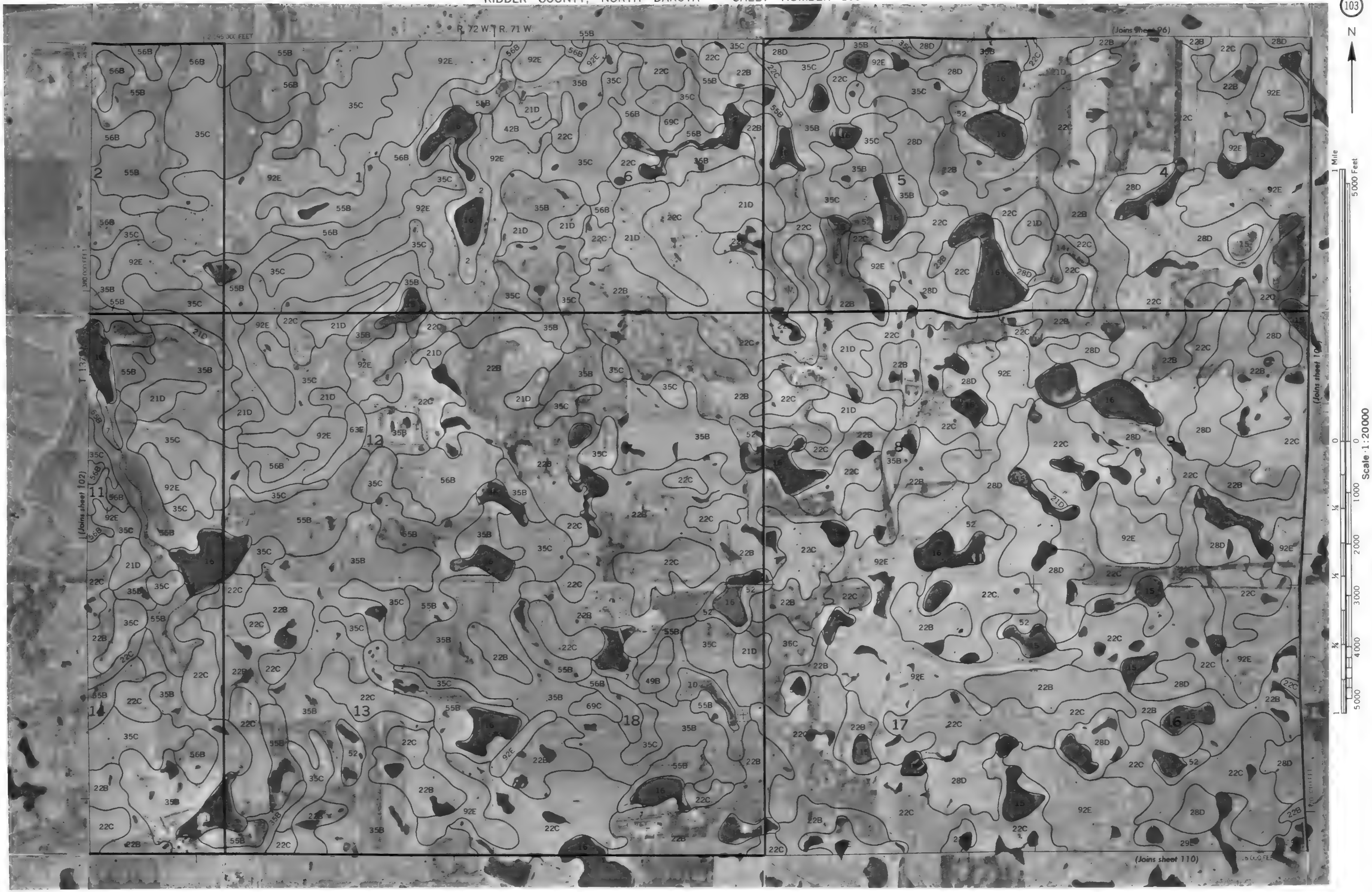
KIDDER COUNTY, NORTH DAKOTA NO. 101

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



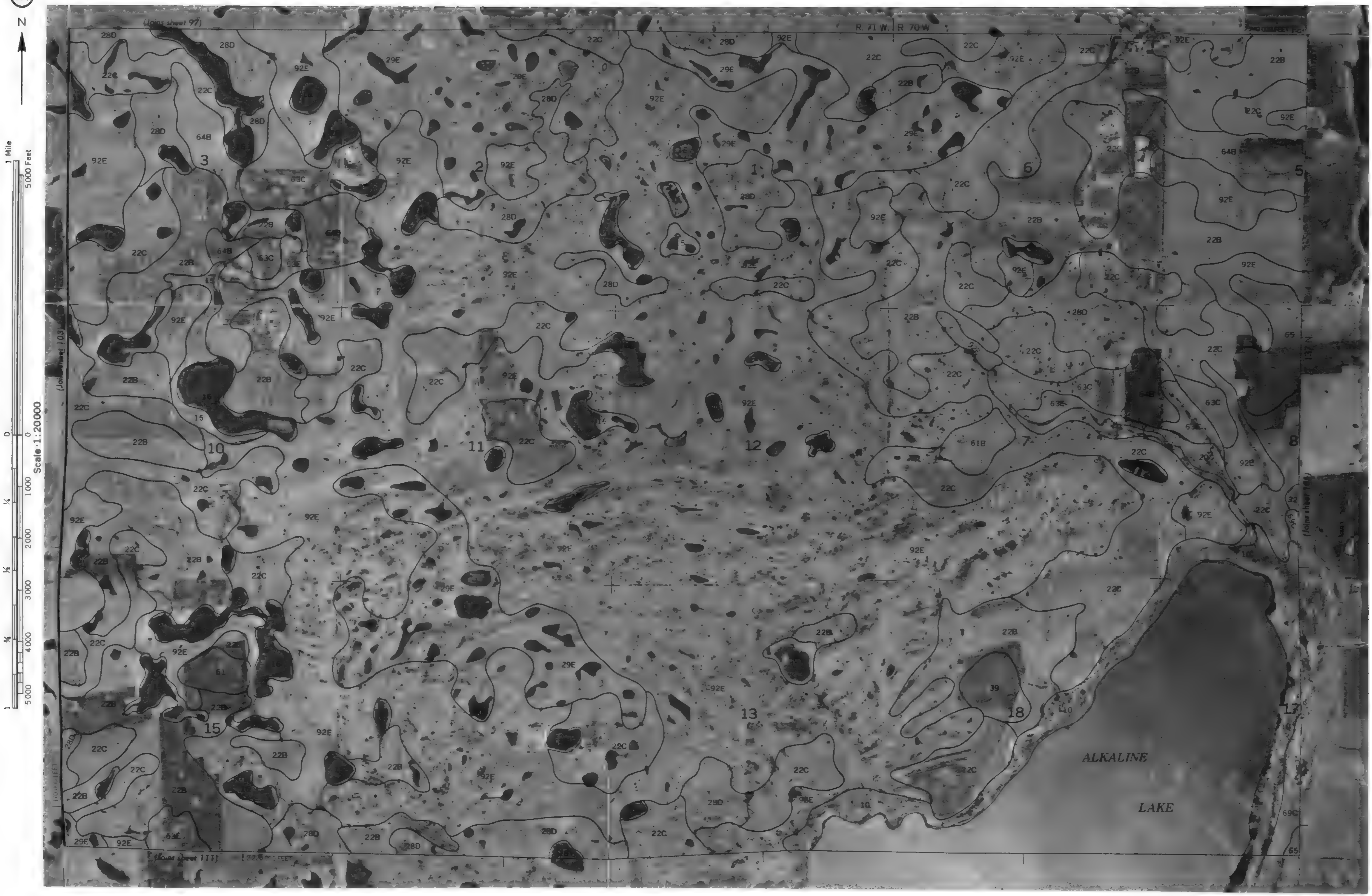
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

KIDDER COUNTY, NORTH DAKOTA — SHEET NUMBER 103



KIDDER COUNTY, NORTH DAKOTA NO. 103

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

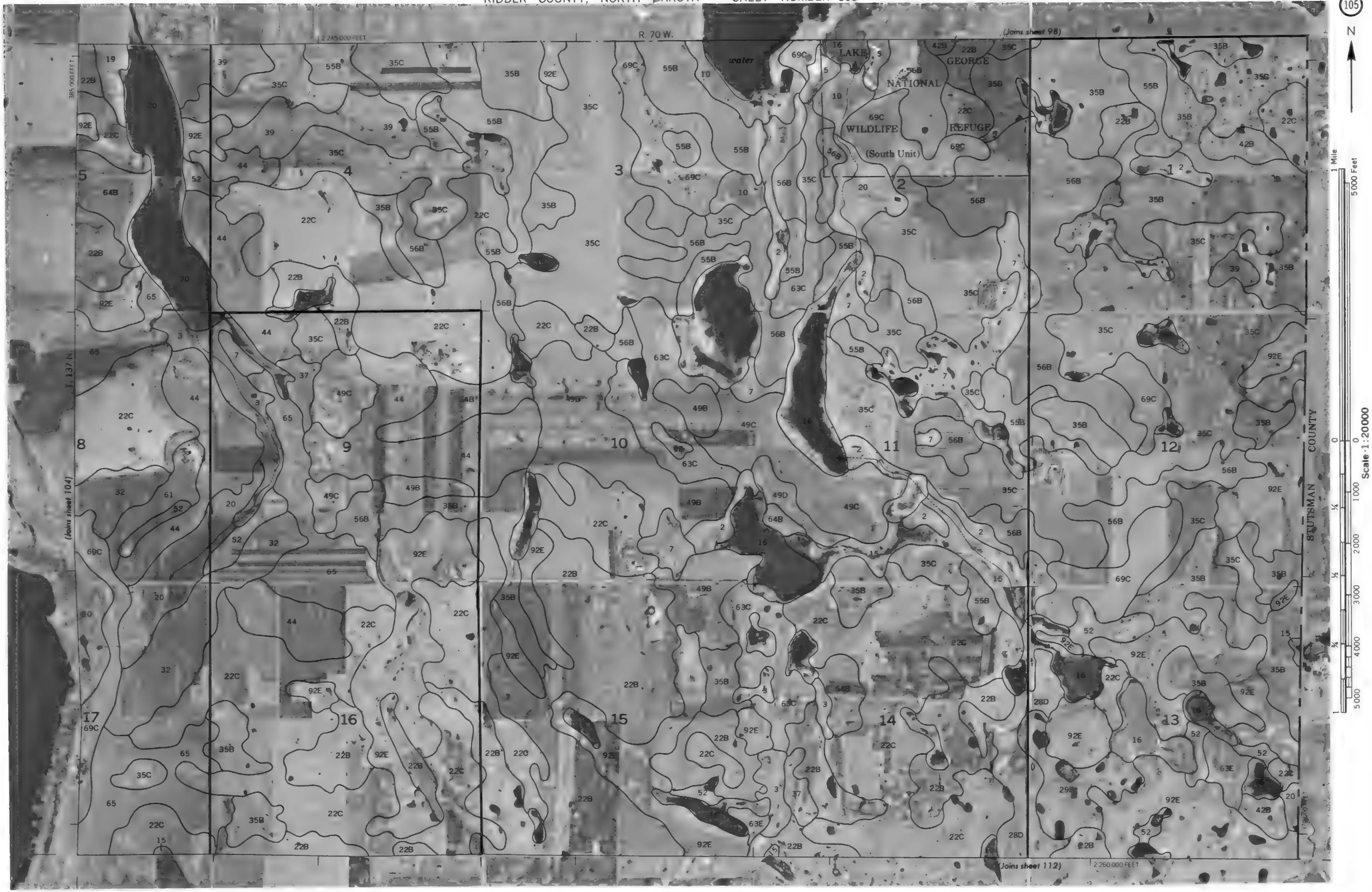


This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

KIDDER COUNTY, NORTH DAKOTA NO. 104

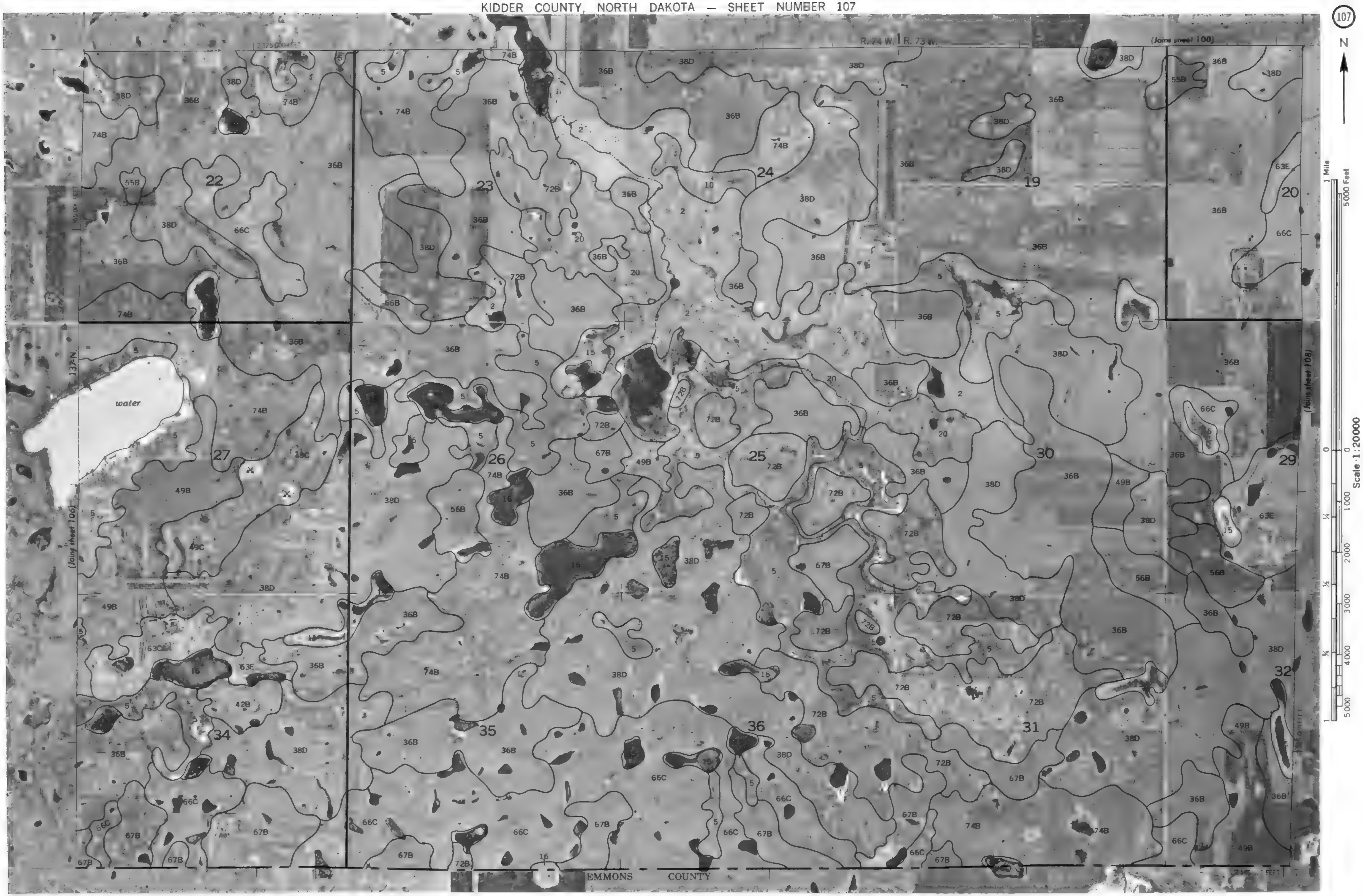
KIDDER COUNTY, NORTH DAKOTA NO. 105

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

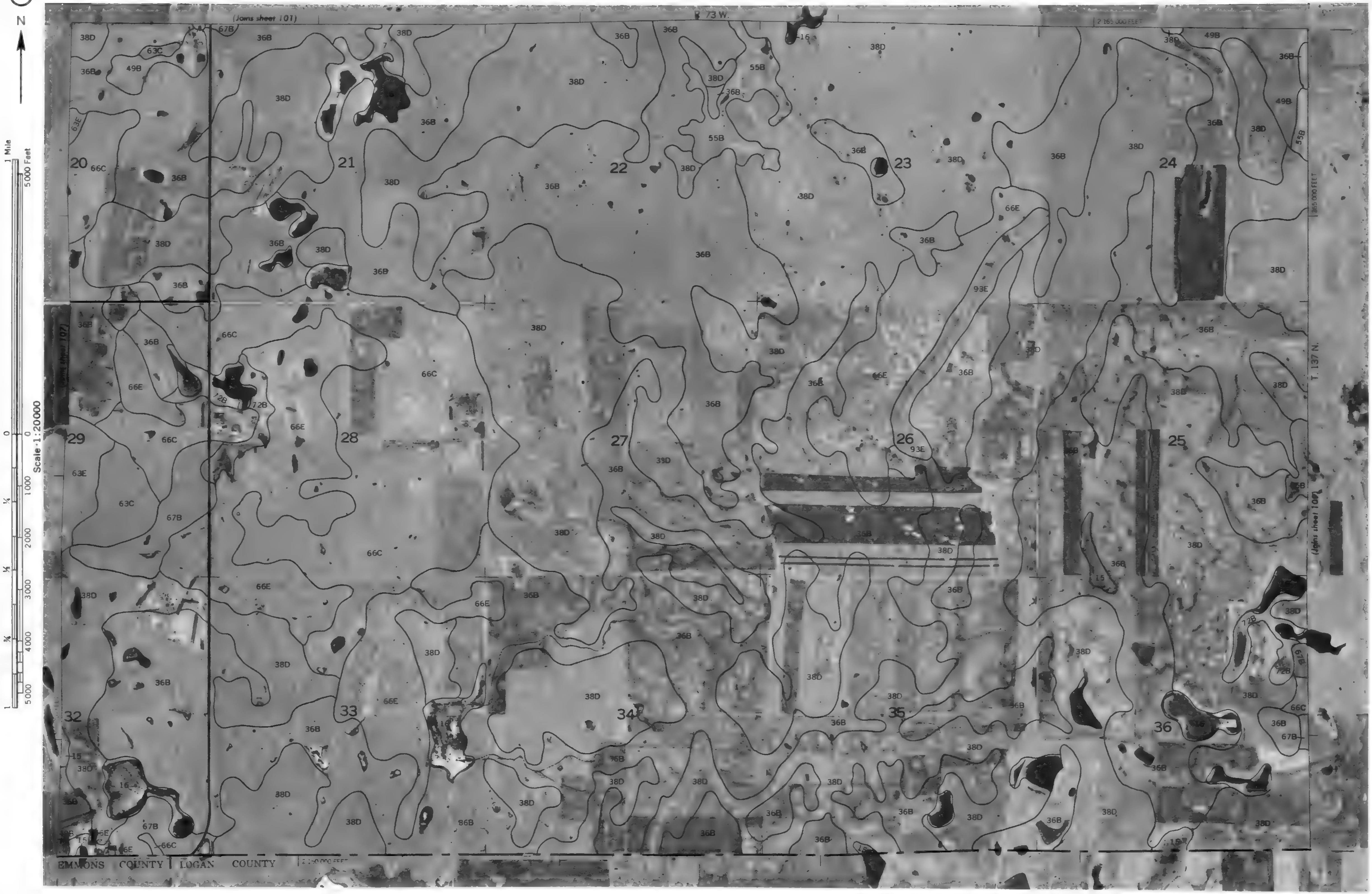
KIDDER COUNTY, NORTH DAKOTA — SHEET NUMBER 107



KIDDER COUNTY, NORTH DAKOTA NO. 107

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

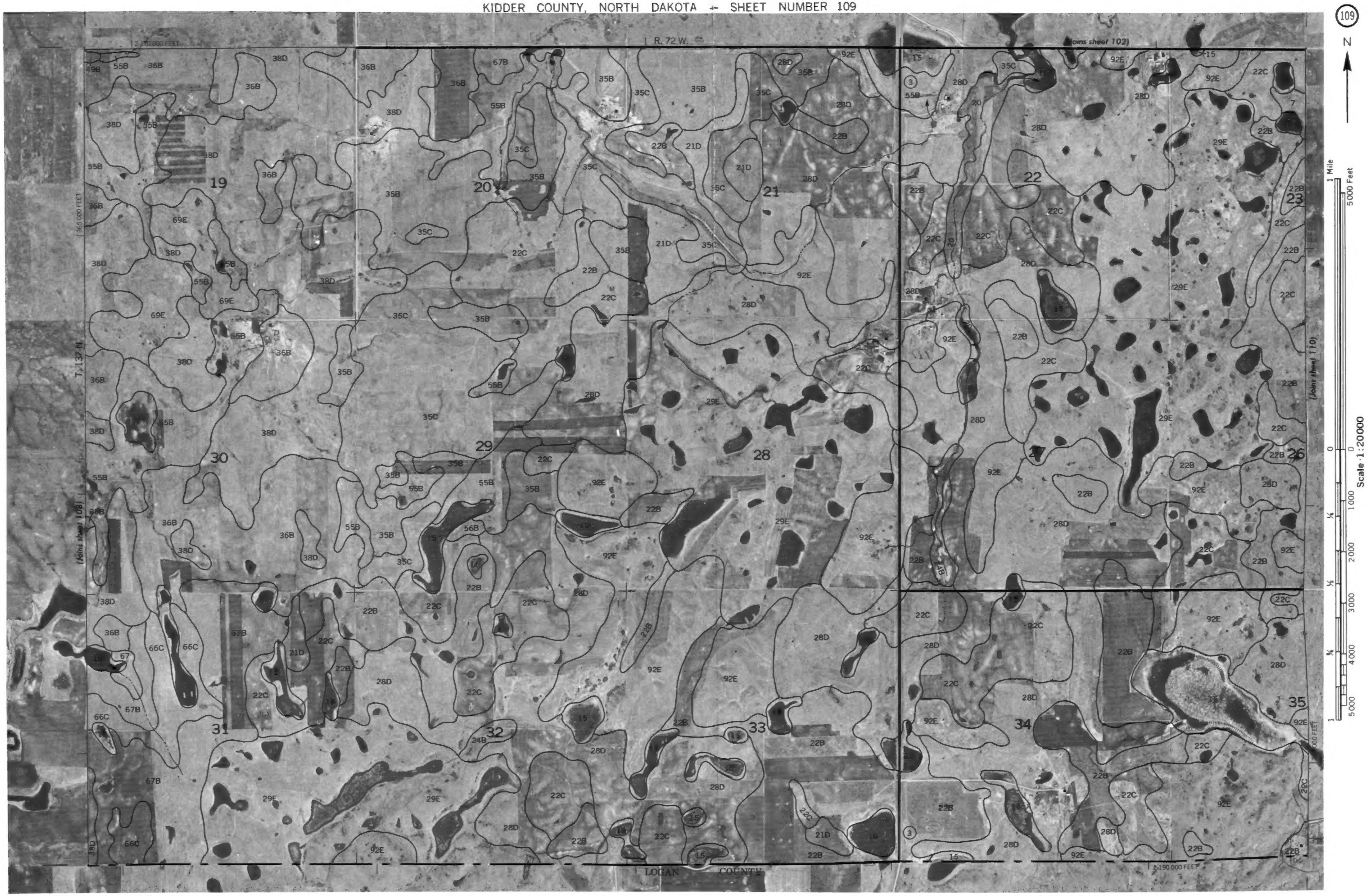
KIDDER COUNTY, NORTH DAKOTA — SHEET NUMBER 108



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

KIDDER COUNTY, NORTH DAKOTA NO. 108

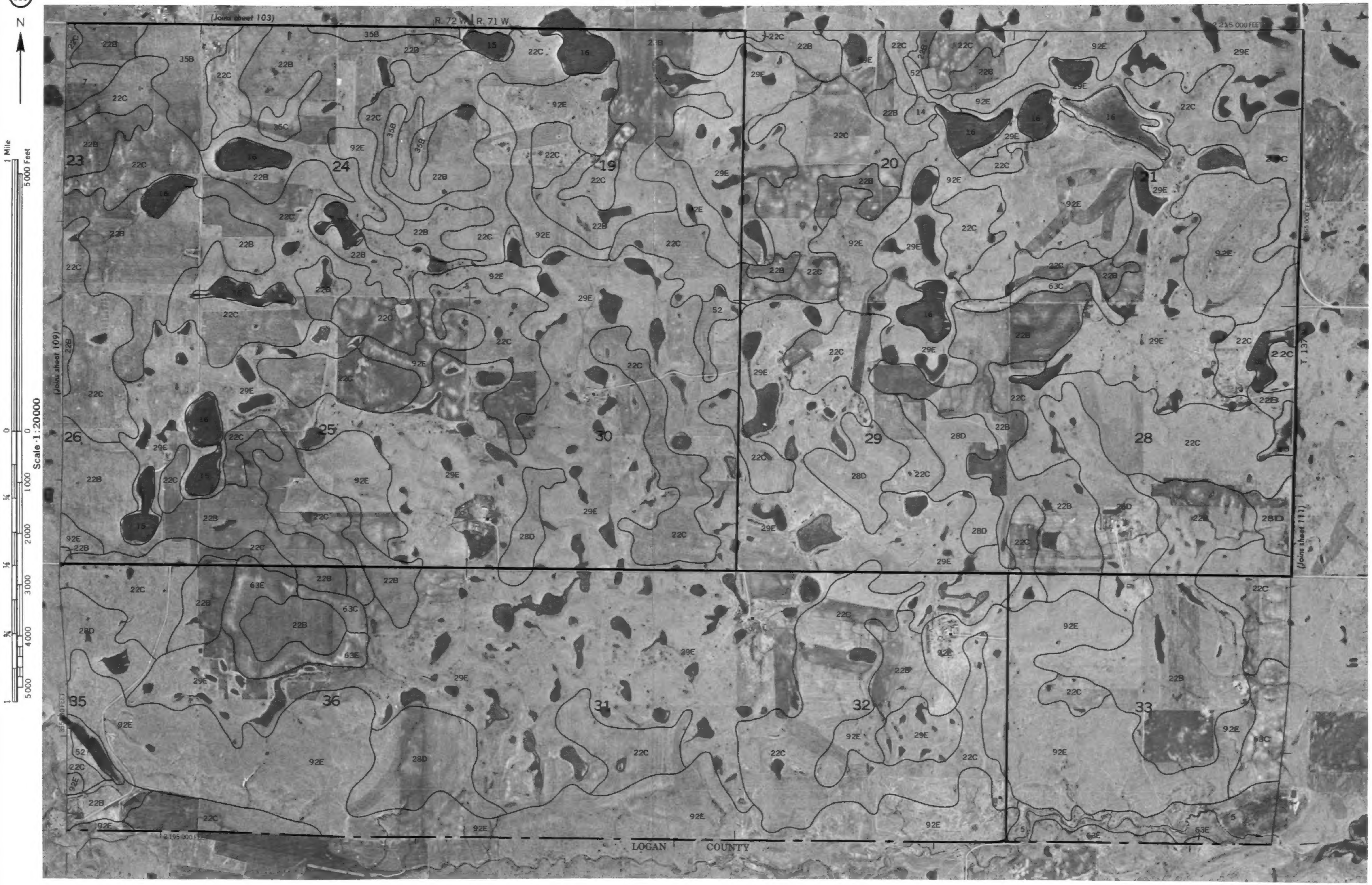
KIDDER COUNTY, NORTH DAKOTA — SHEET NUMBER 109



KIDDER COUNTY, NORTH DAKOTA NO. 109

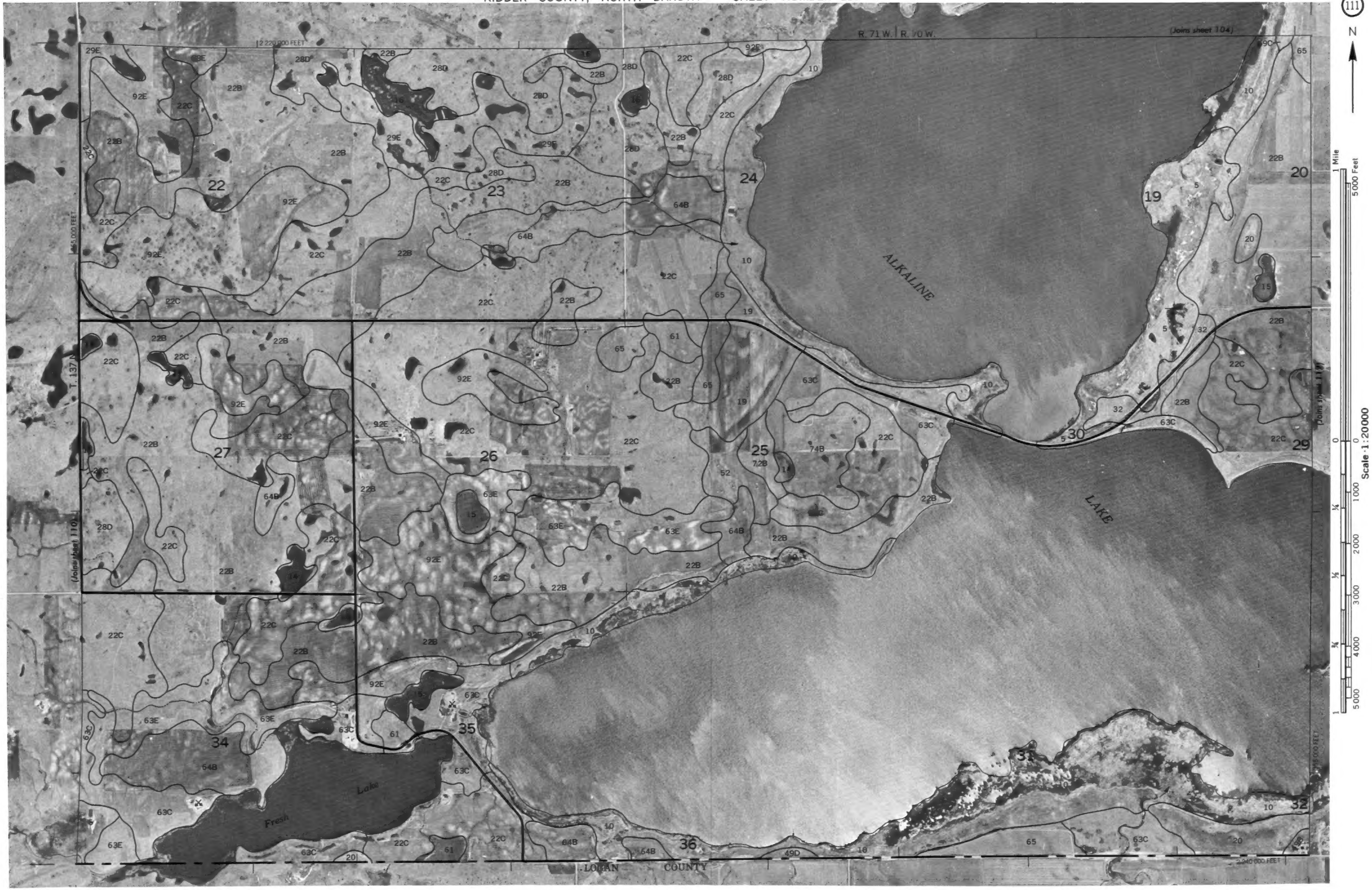
This map is compiled on 1976 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

(110)



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

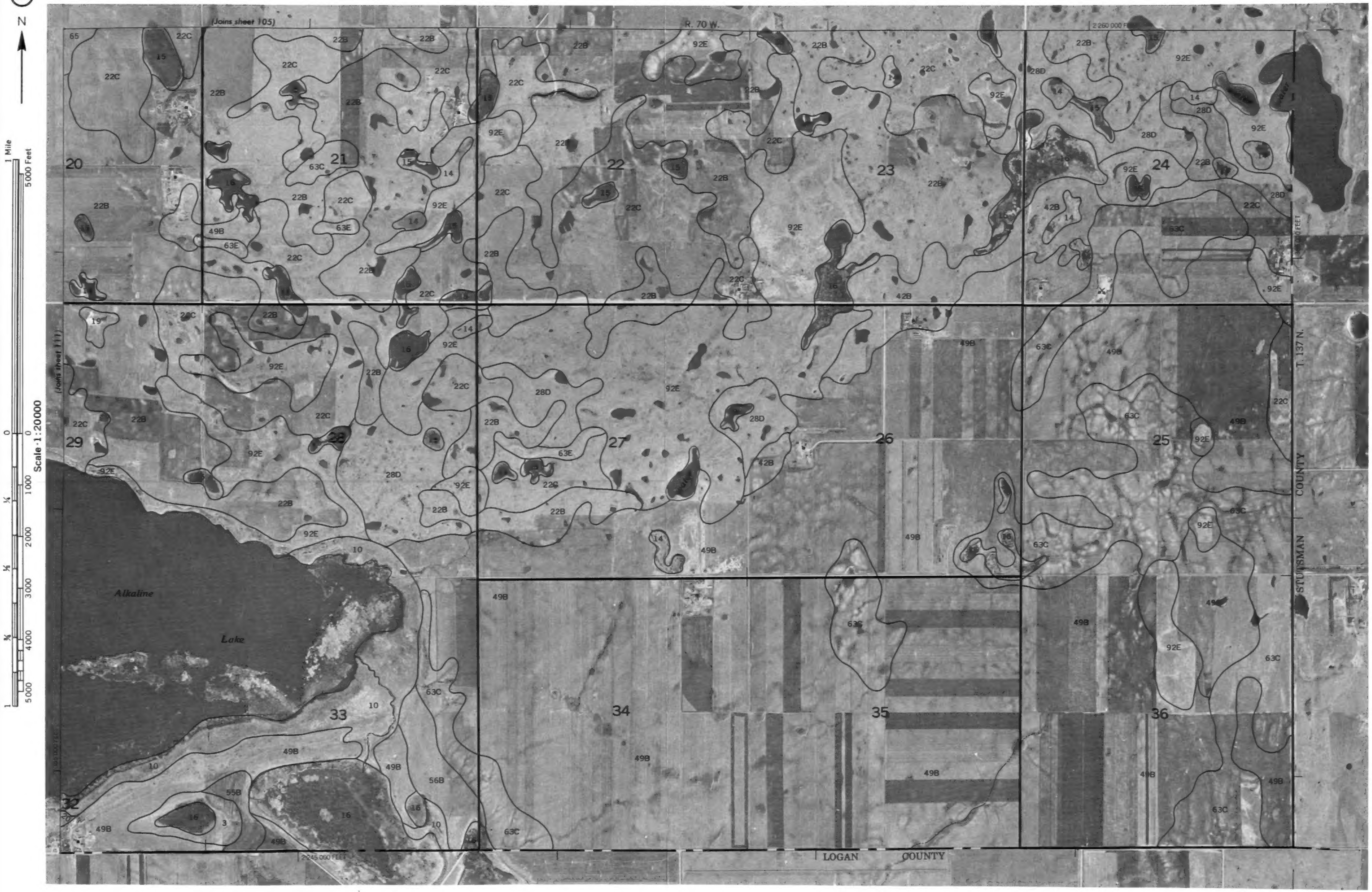
KIDDER COUNTY, NORTH DAKOTA NO. 110



KIDDER COUNTY, NORTH DAKOTA NO. 111

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

KIDDER COUNTY, NORTH DAKOTA — SHEET NUMBER 112



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

KIDDER COUNTY, NORTH DAKOTA NO. 112